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Assessment Groundwater Monitoring Plan for Single Shell Tank Waste management Area S-SX

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Westinghouse Hanford Company, Richland, WA 99352
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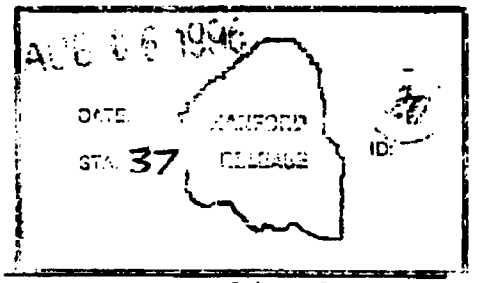
Abstract: Single Shell Tank Waste management Area S-SX has been placed into groundwater quality assessment monitoring under interim-status regulations by direction from the State of Washington Department of Ecology. This document presents background and an assessment groundwater monitoring plan to evaluate any impacts of risks/spills from these Single Shell Tanks in WMA S-SX or groundwater quality.



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CONTENTS

APPENDICES

APPENDICES (cont)

FIGURES

TABLES

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0393	inches
inches	2.54	centimeters	centimeters	0.393	inches
feet	0.3048	meters	meters	3.2808	feet
yards	0.914	meters	meters	1.09	yards
miles	1.609	kilometers	kilometers	0.62	miles
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092	square meters	square meters	10.7639	square feet
square yards	0.836	square meters	square meters	1.20	square yards
square miles	2.59	square kilometers	square kilometers	0.39	square miles
acres	0.404	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.0352	ounces
pounds	0.453	kilograms	kilograms	2.2046	pounds
short ton	0.907	metric ton	metric ton	1.10	short ton
Volume			**Volume**		
fluid ounces	29.57	milliliters	milliliters	0.03	fluid ounces
quarts	0.95	liters	liters	1.057	quarts
gallons	3.79	liters	liters	0.26	gallons
cubic feet	0.03	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.76456	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Force			**Force**		
pounds per square inch	6.895	kilopascals	kilopascals	1.4504×10^{-4}	pounds per square inch

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE., Second Ed., 1990, Professional Publications, Inc., Belmont, California.

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GROUNDWATER WATER QUALITY ASSESSMENT MONITORING PLAN FOR SINGLE-SHELL TANK WASTE MANAGEMENT AREA S-SX

1.0 INTRODUCTION

The groundwater monitoring program conducted for the Single-Shell Tank (SST) Waste Management Area (WMA) S-SX located in southern 200 West Area (Figure 1) will be changed from a detection-level to a groundwater quality assessment program as described in WAC 173-303-400 (refer to 40 CFR 265 Subpart F). This action is in response to a Washington State Department of Ecology (Ecology) letter of May 24, 1996 (Appendix A). The basis for this change is (1) specific conductance in downgradient monitoring wells at the SX Tank Farms exceeded the background critical mean of 248.6 μmho/cm calculated based on one upgradient well 299-W23-14 and three downgradient wells (299-W23-15, 299-W22-39, and 299-22-46); and (2) ^{99}Tc, a significant component of waste in the SSTs in WMA S-SX, exceeded the 900 pCi/L Drinking Water Standard (DWS) in at least one downgradient well (299-W23-15) from April 1992 until March 1994. ^{99}Tc also has been found in several non-RCRA groundwater monitoring wells within the perimeter fence of WMA S-SX. Although ^{99}Tc also was discharged to various cribs and french drains surrounding WMA S-SX, isotopic ratios of analytes in groundwater (e.g., $^{99}Tc/U$ and $^{3}H/^{99}Tc$) indicate the existence of two separate contaminant populations: (1) a high ratio, high ^{99}Tc concentration group in a narrow zone immediately beneath the SX Tank Farm and (2) a low ratio, low ^{99}Tc concentration group in the adjacent monitoring wells surrounding WMA S-SX (refer to Appendix B, Figure B-2). One likely source of the high ^{99}Tc concentrations in downgradient groundwater wells is the WMA S-SX SSTs. Alternative sources are adjacent cribs and related waste handling systems. Because the RCRA groundwater monitoring data suggest the SSTs within WMA S-SX could be impacting groundwater quality, an assessment monitoring plan was requested by Ecology to address this issue.

2.0 SCOPE AND OBJECTIVES

The purpose of this document is to present a groundwater quality assessment monitoring plan for the WMA S-SX in accordance with RCRA interim status groundwater monitoring regulations (40 CFR 265 Subpart F and WAC 173-303-400). Some of the work has begun and a status is in Appendices B and E, but, further work is needed. Accordingly, the primary objective is to determine if the observed changes in groundwater quality are due to the regulated unit, and if so, identify sources, driving force, and pathway(s) to groundwater so that corrective measures can be taken. A fundamental step in development of the assessment plan is a conceptual model. This involves conceptualization of waste migration through the vadose zone to groundwater and is an integral part of the data quality objective (DQO) process. Appendix B describes the conceptual model development in detail. Figure 2 is a flow chart that depicts the key elements used for the WMA S-SX groundwater quality assessment.

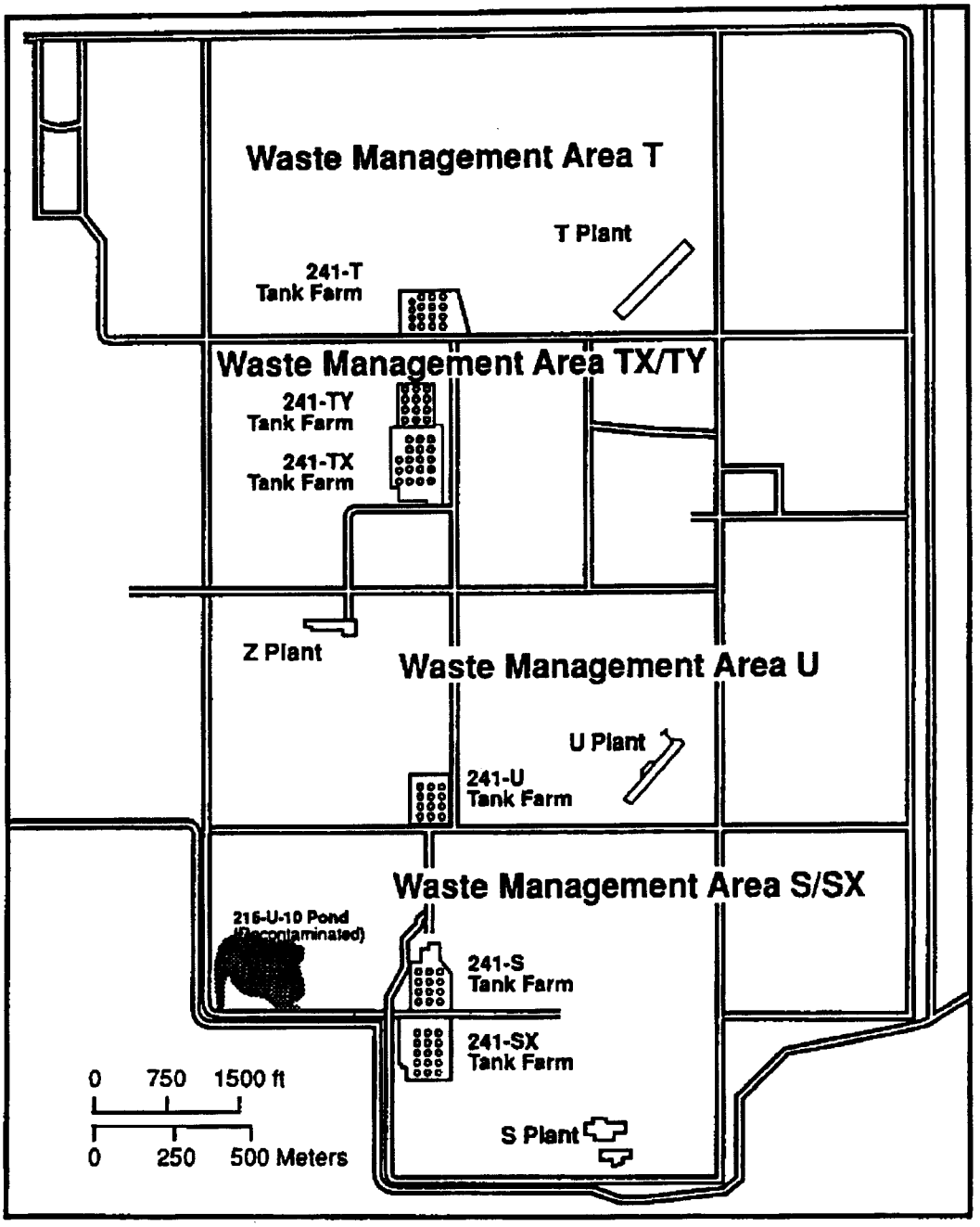


Figure 1. Location Map of WMA S-SX.

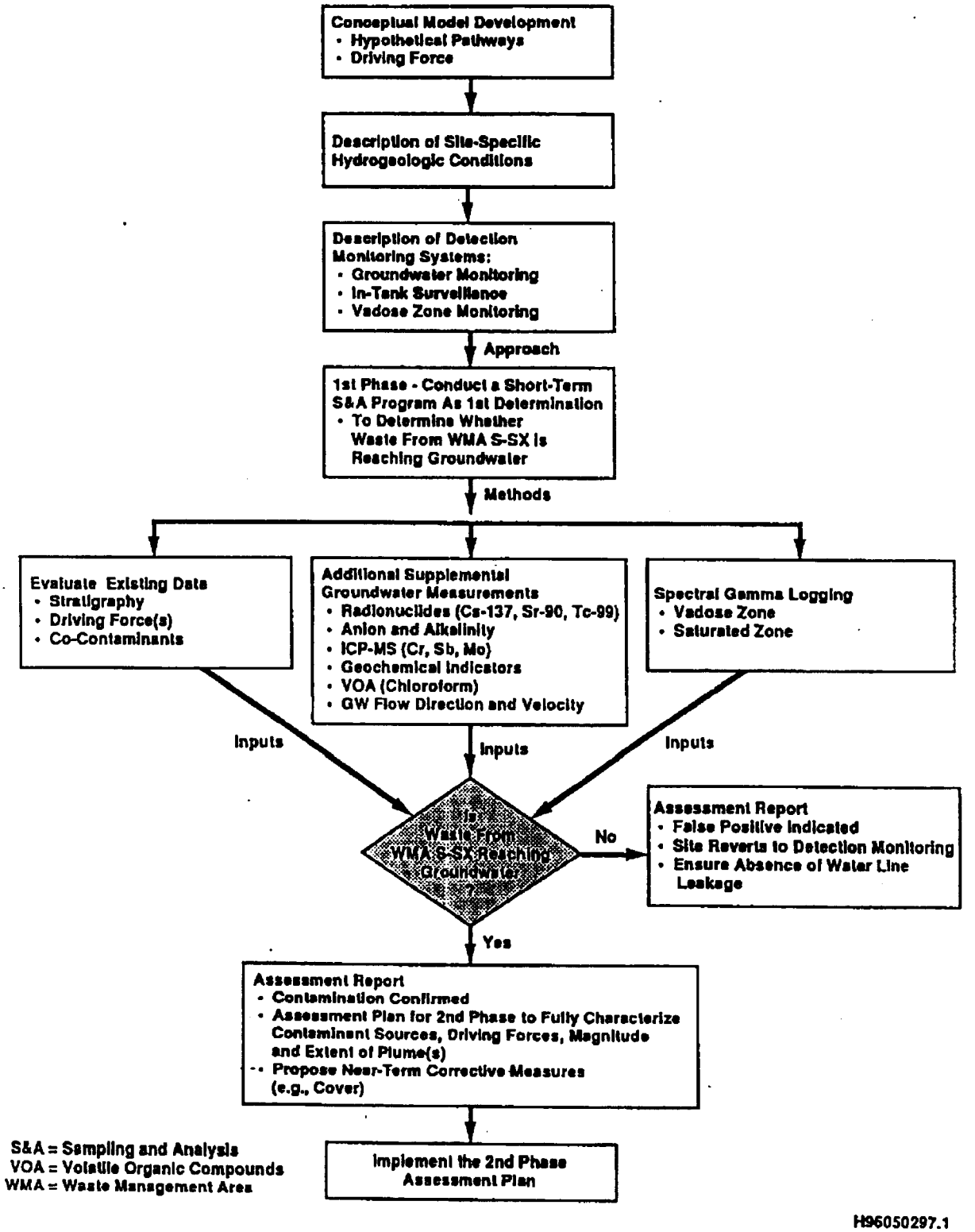


Figure 2. Flow Chart for Phase I Groundwater Quality Assessment Monitoring Program.

As indicated in Figure 2, a two-phased approach is used to address the objectives stated previously. Phase I is designed to address the question "Is waste from the WMA S-SX reaching groundwater?" The emphasis is on quickly assessing the likelihood that the regulated unit is (or was) causing degradation in ambient groundwater quality, and on identifying near-term corrective measures. If a phase II study is conducted, the study would be incorporated in the ongoing Tank Waste Remediation System (TWRS) effort to characterize the nature and extent of tank waste in the vadose zone beneath the tank farms to facilitate remediation/closure.

3.0 HYDROGEOLOGIC CONDITIONS

Understanding the hydrogeology in the vicinity of the regulated unit is fundamental to interpretation of contaminant sources, subsurface contaminant migration, and plume distribution patterns. Thus, this section summarizes the existing stratigraphic and hydrologic information relevant to assessing possible contaminant sources and pathways to groundwater beneath the S-SX Tank Farms.

A schematic illustration of hydrologic and stratigraphic relationships and potential preferential pathways beneath the WMA S-SX is shown in Figure 3. A generalized stratigraphy and hydrology are depicted in Figure 3 and are discussed in the previous sections.

3.1 STRATIGRAPHY

Geology of the 241-S and 241-SX Tank Farms originally was compiled by Price and Fecht (1976a, 1976b) shortly after the dry well boreholes were completed in the early 1970s. More recent interpretations of the stratigraphy of the suprabasalt sediments have been made by Lindsey (1992).

The major stratigraphic units of the suprabasalt unconfined aquifer present beneath WMA S-SX are the Ringold Lower Mud, Ringold Unit E, Plio-Pleistocene (including Early Palouse), and the Hanford formation (in ascending order). Ringold Lower Mud consists of laminated to massive silt and silty fine sand deposited mostly as overbank deposits, but with some volumetrically small interbedded lacustrine silt and clay. The overlying Ringold Unit E is dominantly a matrix to clast supported pebble and cobble gravel in a fine to coarse sand matrix. Cementation by calcium carbonate, iron oxide, and silica in places is extreme, making this unit a lithified sedimentary rock that can inhibit water movement or locally confine water beneath. Sand and silt lenses and beds are common in places. Lenses and beds of fine to medium sand are loosely cemented and have, at times, flowed into wells with perforated carbon steel casing. The water table is presently at depth of 210 to 215 feet in the Ringold Unit E, with up to 40 feet in the vadose zone and up to 180 feet in the saturated zone overlying Ringold Lower Mud. Upper Ringold thinly bedded and interbedded fine sand and silt is absent beneath WMA S-SX. The Plio-Pleistocene unit consists of up to 12 feet of laminated silt with some intercalated sand overlying up to 10 feet of silt,

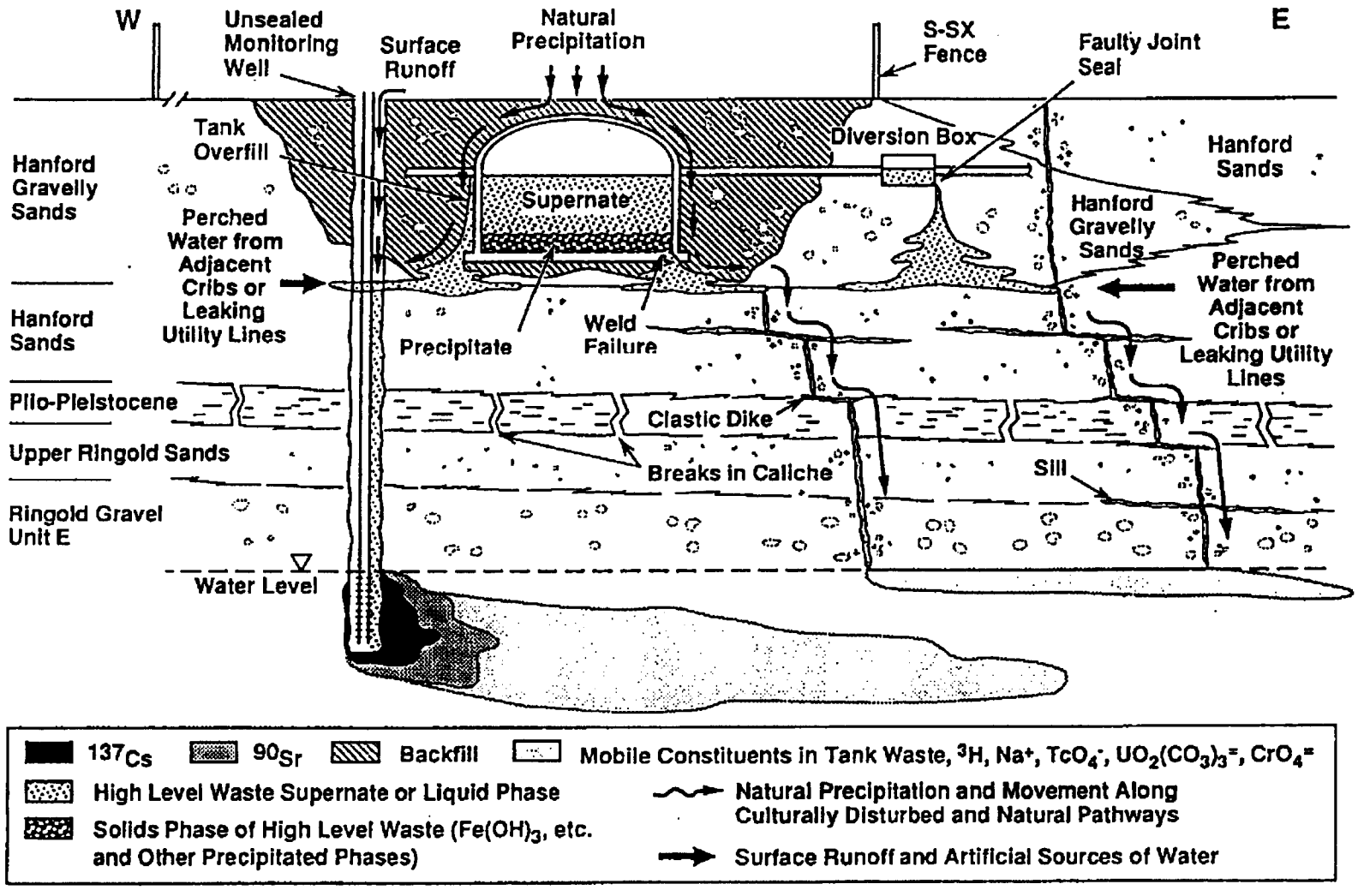


Figure 3. Hypothetical Sources and Potential Pathways to Groundwater in WMA S-SX.

sand, and gravel variably cemented by calcium carbonate (caliche). The caliche can be massive, but thickens and thins unpredictably and in places is nearly absent. Massive caliche is often fractured. This unit is present in the vadose zone and might perch water; however, its extreme lateral and vertical variability and degree of cementation lead to different effects on infiltrating liquids over short distances of a few feet to tens of feet.

Two units of the Hanford formation are present: an upper coarse unit and a lower fine-grained sandy unit. The lower unit is slightly silty fine to medium sand that is well stratified. Thin plane to massively bedded sand strata might be present, as well as 2- to 5-feet-thick fining upward sequences beginning with medium to coarse sand and grading upward through current rippled fine sand to an overlying silt bed or drape that could include some clay. Both units thicken and thin laterally and the percentage of mud varies in both lateral and vertical directions. Some clay could be present, mostly as clay-sized quartz and feldspar, but with some micas. The lower Hanford formation generally thickens and becomes finer grained to the south. There is a high degree of vertical and lateral heterogeneity in this unit that can have a profound influence on fluid flow and contaminant transport. Some carbonate-rich paleosols could be present in this unit, which can be up to 150 feet thick. The overlying upper unit of the Hanford formation is highly variable in grain size distribution, but is generally very coarse to medium grained sand that is slightly pebbly. Some fine to medium sand and silt could be present. The upper unit typically is plane bedded, with large scale planar cross bedding in places. Strata generally are lenticularly shaped, with erosional and depositional pinchouts common. This unit is about 20 feet thick in the northern part of WMA S-SX and thins to the south, interfingering with the finer grained lower unit of the Hanford formation. Up to 15%, but generally lower percentages of smectite and chlorite, could be present in an otherwise quartzo-feldspathic unit.

Backfill is a mix of Hanford formation coarse and fine units that is slightly pebbly to slightly silty sand from which the larger clasts were removed before placing back in the excavation. The backfill was placed in 4 foot lifts, so some compaction occurred during construction with the movement of vehicles and equipment across the existing surface. No concerted effort was made to compact the fill, which is 55 feet thick (the base of the tanks).

In general, the upper sedimentary sequences in the vicinity of the WMA S-SX appear to dip toward the southeast. The southwest dip could be important in understanding the formation and possible movement of perched water beneath and adjacent to the regulated unit.

Clastic dikes as preferential pathways. Clastic dikes are common in the Hanford formation and are generally 6 to 16 inches wide. Clastic dikes were mapped by Price and Fecht (1976c) in the excavation for the 241-SY Double-Shell Tank Farm located at the northeast corner of WMA S-SX. The same geologic units underlie the S and SX Tank Farms (WMA S-SX) so their presence is considered highly likely. Clastic dikes commonly have exterior margins of thin (less than 0.25 inch) clayey silt (locally termed clay skins). There might be several laminae of similar texture and composition within the

interior of a dike. Within any one dike, strata could be well sorted and continuous while others are discontinuous. Delicate sedimentary structures could be present in some, while others contain more massive bedding. The vertical and lateral variation in grain size and strata within a dike can be abrupt and extreme. Smaller dikes and/or sills could branch from any one dike. Clastic dikes were mapped recently in the excavation for the Environmental Restoration Disposal Facility (ERDF) in similar geologic units of the Hanford formation (Fecht and Weekes 1996).

Where clastic dikes intersect the ground surface, the dikes form patterned ground that can be recognized from aerial photographs as zones of more intense vegetation (presumably because of greater water retention capacity than the surrounding 'host rock'. Fecht and others (1994) have found a relationship between the size of the clastic dikes and the diameter of the polygons that these form. Clastic dikes in the SY and ERDF excavations are generally of a width that the polygons formed by the these dikes are on the order of 50 to 90 feet in diameter. Considering that the SSTs in WMA S-SX are 75 feet in diameter with 100 feet between adjacent tank centers, it is highly likely that several clastic dikes are intercepted by tanks or dry wells within the S and SX Tank Farms and could serve as preferential pathways to influence both lateral and vertical movement of liquids and contaminants. Clastic dikes could intersect the bottom and sides of the excavation for the tanks, could intersect the bottom of a tank or lateral lines beneath a tank, could intersect various other structures within a tank farm that could release liquids, or could intercept one of numerous unsealed boreholes or partially sealed groundwater monitoring wells within WMA S-SX.

Clastic dikes can have a significant effect on the movement of liquids and thus the transport of contaminants. If liquid is added directly above a clastic dike, the 'clay skins' could restrict and confine infiltration to the width of the dike, thereby preferentially enhancing vertical transport. If liquid impinges laterally on a dike, fluids could be temporarily 'dammed' before the clay skin becomes saturated to allow infiltration into the interior of a dike. Varying grain sizes of units and bedding within a dike could further influence the movement of liquids within a dike.

3.2 HYDROLOGY

Groundwater movement beneath the subject TSD unit is influenced by both historical discharges and water table gradients in the immediate area and by the geology of the aquifer host rock.

3.2.1 Water Levels

The WMA S-SX is located southeast of the now decommissioned 216-U-10 Pond under which a water table mound developed. The U Pond received about 43,000,000 gallons of liquid effluent from 1944 to its decommissioning in 1984, resulting in a rise of about 70 feet in the water table elevation. This water table mound has controlled the general direction of groundwater flow to

the east-southeast beneath WMA S-SX since the inception of operations of these farms in the early 1950s.

3.2.2 Groundwater Flow Rate and Direction

When U Pond was decommissioned in 1984, the 216-U-14 (U-14) ditch (which carried liquid effluent to U Pond) was backfilled to a location north of the 242-S Evaporator (north of WMA S-SX). Liquid effluent continued to flow and infiltrate along the ditch to the point of damming. The decommissioning and continued discharges to the U-14 ditch resulted in a decline of the water table mound beneath U Pond and a northeastward shift of the apex of the mound. Groundwater flow is now more south-southeasterly as is apparent by the distribution of tritium in groundwater monitoring wells in WMA S-SX [Figure 4.a and 4.b (tritium and technetium plume maps superimposed on existing water table map)].

An area of lower hydraulic conductivity in the southwest part of WMA S-SX, perhaps corresponding to a more heavily cemented zone in the Ringold Unit E, was delineated by Connelly et al (1992). This zone could result in preferential flow at higher velocity around the area of reduced hydraulic conductivity. Confirmation of groundwater flow direction with borehole velocity flowmeter readings is proposed in several wells as part of the assessment monitoring program. Changes in water levels in the area of WMA S-SX are illustrated in Figure 5, which shows hydrographs of RCRA wells and a hydrograph for well 299-W23-4, located west of WMA S-SX between the tank farm and the site of the former U Pond. Water level has declined in this well about 15 feet since 1984. Flow rates based on both predictions from Darcy's law and observed plume movement are on the order of 0.5 to 1 foot/day in the vicinity of the WMA S-SX.

4.0 DESCRIPTION OF DETECTION MONITORING SYSTEM

This section describes the detection monitoring system for the RCRA groundwater monitoring program. Historic surveillance conducted to monitor the integrity of the SSTs and spectral gamma logging conducted in boreholes surrounding the SSTs are described in Appendix C.

4.1 WELL NETWORK

Seven RCRA wells surround WMA S-SX (Figure 6): two upgradient wells (299-W23-13 and 299-W23-14) and five downgradient wells (299-W22-39, 299-W22-44, 299-W22-45, 299-W22-46, and 299-W23-15). The detection groundwater monitoring network was designed for a southeast direction of groundwater flow. The MEMO model indicates that the efficiency of the present network is about 85% for a southeast direction of groundwater flow (Caggiano and Goodwin 1991, p. 111). Hydrographs of RCRA wells (Figure 5) indicate that wells 299-W23-13 and 299-W23-14 have higher hydraulic heads than those on the east and south side of WMA S-SX and are still upgradient wells.

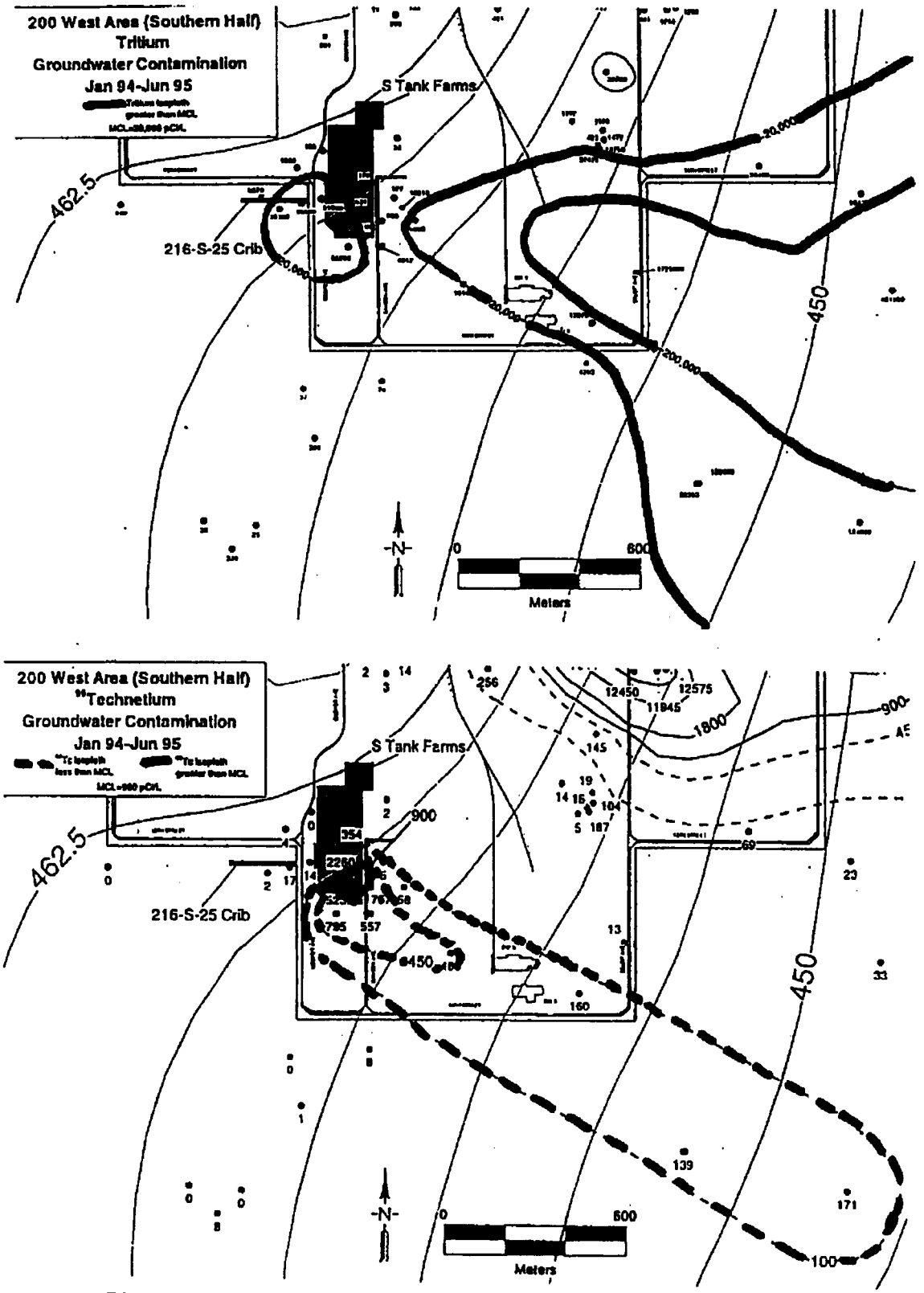


Figure 4. Tritium and Technetium Groundwater Plume Maps.

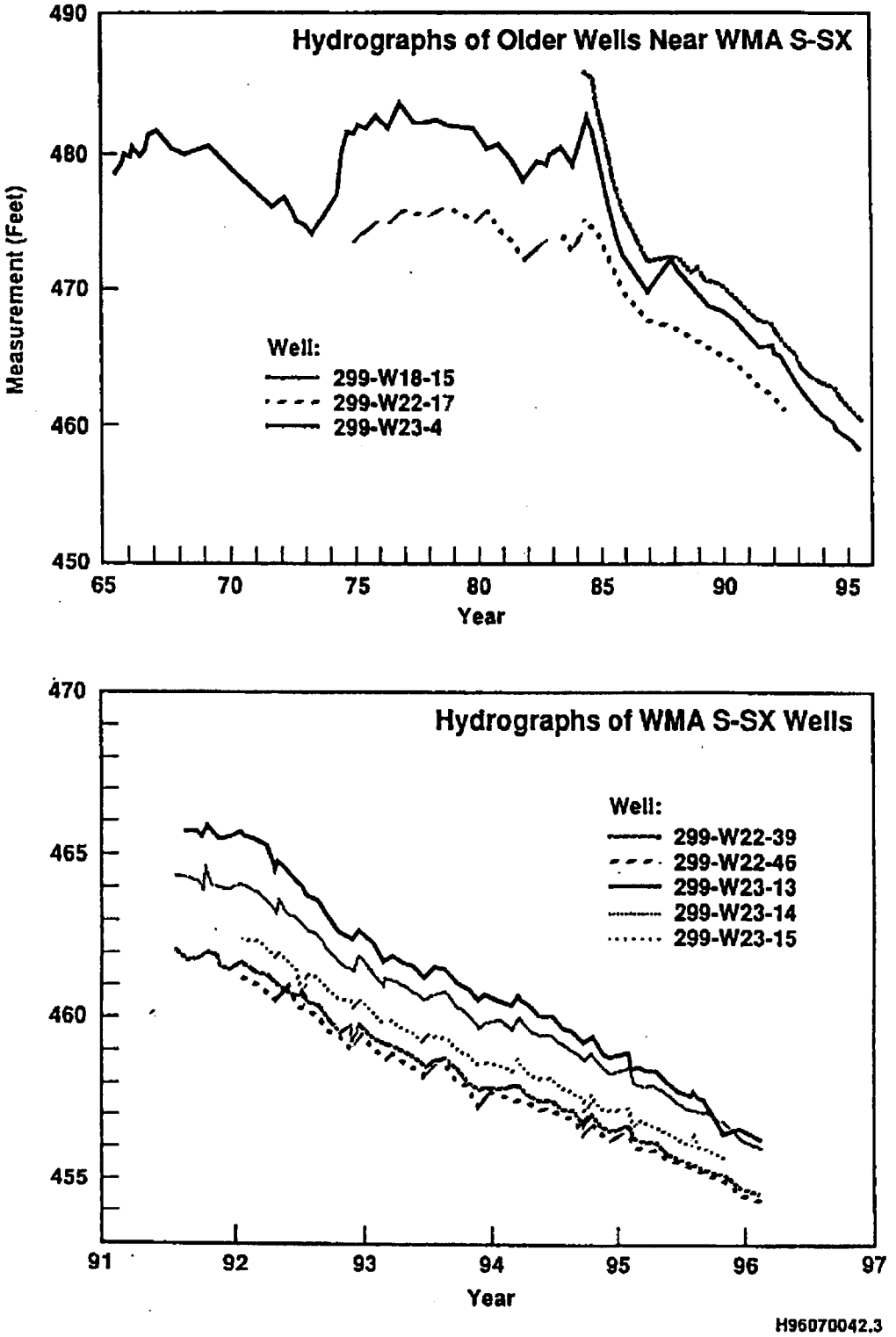


Figure 5. Hydrographs of RCRA and Older Wells Around WMA S-SX.

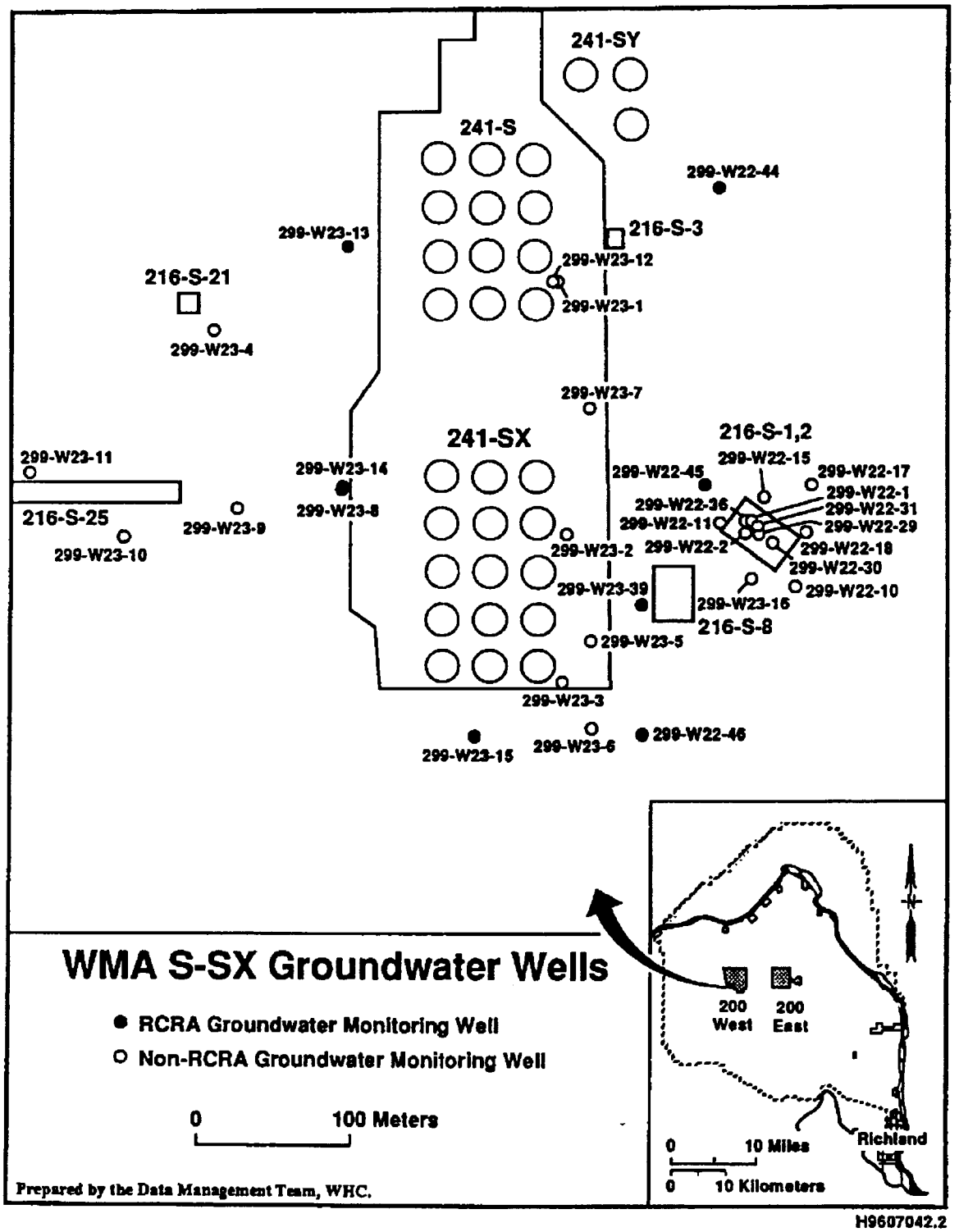


Figure 6. Map of Groundwater Monitoring Wells Around WMA S-SX.

The RCRA well information is summarized in Table 1 and associated as-built diagrams are provided in Appendix D. These wells were constructed between 1990 and 1992 in accordance with the original groundwater monitoring plan for the SSTs (Jensen et al. 1989) and revision (Caggiano and Goodwin 1991). All wells were constructed using cable tool methods and were completed as 4-inch diameter wells with stainless steel casing and screens, filter pack, full annular (bentonite crumbles), and surface seals (Caggiano 1992; 1993). All RCRA wells comply with construction specifications in WAC 173-160. All wells have either a 20- or 35-foot screen, with 35 foot screens installed after concurrence with Ecology because of rapidly declining water levels. All wells were located outside the perimeter fences of tank farms and at least 100 feet from the nearest tank by agreement with Ecology to prevent the driving of contaminants deeper into the vadose zone during well construction.

Several older carbon steel wells are located within and around WMA S-SX. These wells are listed in Table 1 as wells that were constructed of carbon steel casing perforated over variable-length intervals within the uppermost aquifer. Many of the older wells were constructed adjacent to cribs that were intended to be monitored. Although not constructed according to RCRA specifications, these wells have been used to provide supplementary information that aids data interpretation as permitted by the jointly issued policy of Ecology and EPA on existing wells.

4.2 SUMMARY OF RCRA SAMPLING/ANALYSIS RESULTS

Quarterly sampling for DWS, Water Quality Parameters, Indicator Parameters, and site-specific constituents was completed in 1993. Semi-annual sampling has been conducted in accordance with the groundwater monitoring plan. Tritium has exceeded the DWS in upgradient well 299-W23-14 and downgradient well 299-W23-15 (Figure 7). ^{99}Tc has exceeded the 900 pCi/L DWS in downgradient well 299-W23-15 (1993), but has declined to below the DWS since 1994 (Figure 7). The concentration of ^{99}Tc in downgradient wells 299-W23-15, 299-W22-39, and 299-W22-46 (surrounding SX Tank Farm) has been significantly higher than ^{99}Tc levels observed in the upgradient wells (299-W23-13 and 299-W23-14). Time series plots of selected radionuclides and constituents are shown on Figures 7 and 8, respectively. Variation of field specific conductance with time is shown in Figure 9. Results of sampling and analysis have been reported quarterly to Ecology and EPA.

4.3 NON-RCRA GROUNDWATER MONITORING

A jointly issued policy by Ecology and EPA in July 1990 restricts groundwater sampling for RCRA hazardous waste constituents to wells that comply with construction specifications in WAC 173-160. Any regulatory decisions regarding dangerous or extremely hazardous waste should be based on data obtained from wells that comply with "RCRA construction standards."

Table 1. Groundwater Monitoring Wells in the 241-SX Tank Farm Area.

SX Tank Farm	Well No.	Nearest Facility	Const. Date	Depth (ft.)	Diameter (in.)	Annular Seal	Open Interval
	2-W23-2	SX-104, SX-107	1954	236	8, 4	Partial ('76)	P184 - 235
	2-W23-3	SX-112	1956	232	8, 4	Partial ('76)	P176 - 228
	2-W23-5	SX-112	1969	250	6, 4	Partial ('76)	P170 - 240; S205 - 238
	2-W23-7	SX-101	1969	250	6, 4	Partial ('76)	P170 - 248; S149 - 219
S Tank Farm	2-W23-1	S-107	1952	262	6, 4	Partial ('76)	P180 - 260; S178 - 235
	2-W23-12	S-107; 216-S-3 French Drains	1970	265	6, 4	Partial ('76)	P189 - 230
S-SX RCRA	2-W22-39	SX Tank Farm	1991	223.3	4	Full	S199.8 - 223.3
	2-W22-44	S/SY Tank Farms	1991	246	4	Full	S205.1 - 242.2
	2-W22-45	S Tank Farm	1992	240	4	Full	S198.1 - 233.9
	2-W22-46	SX Tank Farm	1991	241	4	Full	S192.9 - 228.9
	2-W23-13	S Tank Farm	1990	218.2	4	Full	S195.9 - 217.2
	2-W23-14	SX Tank Farm	1991	224.4	4	Full	S194.0 - 215.3
	2-W23-15	SX Tank Farm	1991	225	4	Full	S185.7 - 222.4
S-SX Tank Farm Area	2-W22-1	216-S-1, -S-2 Cribs	1952; 1956	306	8, 6	Partial ('80)	P190 - 280
	2-W22-2	216-S-1, -S-2, -S-8 Cribs	1951; 1956	307	8, 6	Partial ('80)	P195 - 285
	2-W22-6	SX Tk Fm; 216-S-8 Crib	1956	274	8, 6	Partial ('80)	P194 - 273; S170 - 229
	2-W22-10	216-S-1, -S-2 Cribs	1956	312	8, 6	Partial ('87)	P203 - 311
	2-W22-11	216-S-1, -S-2, -S-8 Cribs	1956	308	8, 6	Partial ('80)	P195 - 305
	2-W22-15	216-S-1, -S-2 Cribs	1956	268	8, 6	Partial ('80)	P190 - 263
	2-W22-16	216-S-1, -S-2 Cribs	1956	248	8, 4	Partial ('78)	P190 - 246

Table 1. Groundwater Monitoring Wells in the 241-SX Tank Farm Area.

SX Tank Farm	Well No.	Nearest Facility	Const. Date	Depth (ft.)	Diameter (in.)	Annular Seal	Open Interval
	2-W22-17	216-S-1, -S-2 Cribs	1956	261.5	8, 6	Partial ('80)	P209 - 260
	2-W22-18	216-S-1, -S-2 Cribs	1955, 1966	302	8, 6	Partial ('80)	P212 - 298
	2-W22-29	216-S-1, -S-2, -S-8 Cribs	1966	202	6, 4	Partial ('80)	NP#
	2-W22-30	216-S-1, -S-2, -S-8 Cribs	1966, 1980	231	6, 4	Partial ('80) *	NP*
	2-W22-31	216-S-1, -S-2, -S-8 Cribs	1966, 1980	250	6, 4	Partial ('80)	NP**
	2-W22-36	216-S-1, -S-2 Cribs	1966	206	6, 4	Partial ('80)	
	2-W23-4	216-S-21 Crib	1957	300	8	No	P180 - 295
	2-W23-6	SX Tank Farm	1969	250	6, 4	Partial ('80)	P172 - 248
	2-W23-8	SX Tank Farm	1972	235	6	No	P165 - 230
	2-W23-9	216-S-25 Crib	1972	235	6, 5	Partial ('83)	P164 - 230
	2-W23-10	216-S-25 Crib	1972	235	6, 5	Partial ('83)	P165 - 230
	2-W23-11	216-S-25 Crib	1972	235	6, 5	Partial ('83)	P165 - 230

NOTES:

#NP = Not perforated--hole abandoned because tools lost in well

*Contamination recorded in driller's log during construction

**Perforator contaminated in 1979-80 during deepening of well.

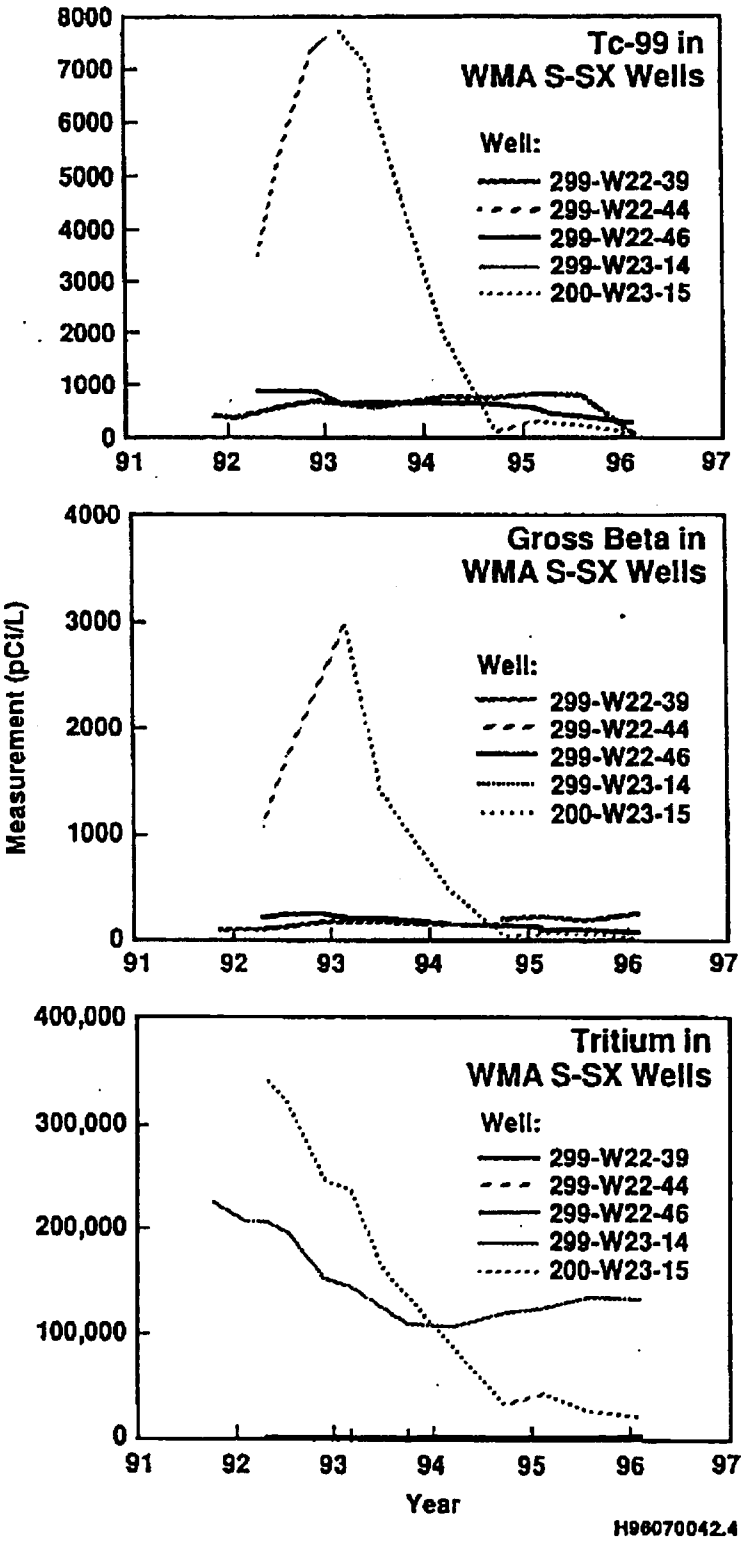


Figure 7. Time Series Plot of Selected Radionuclides for WMA S-SX.

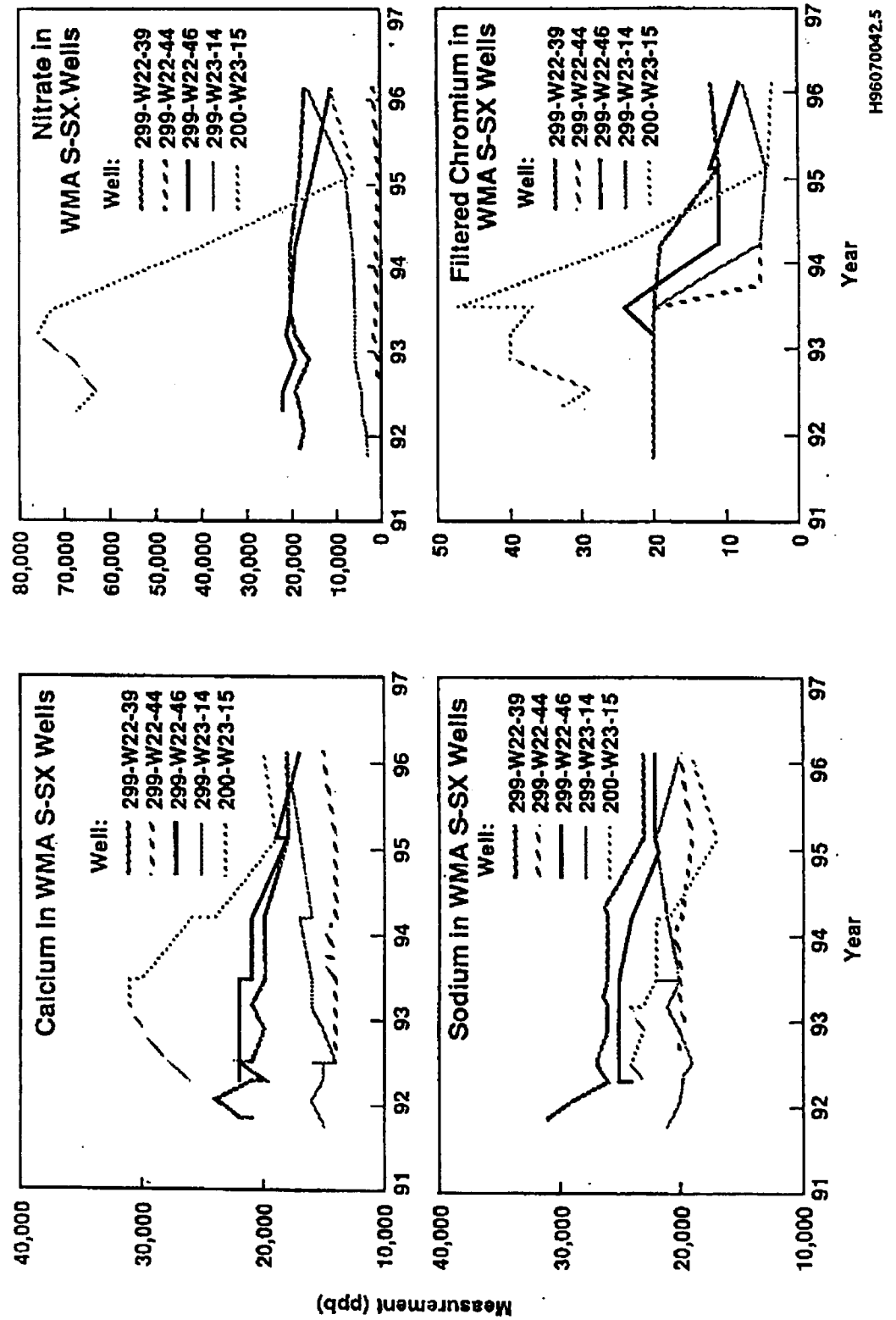
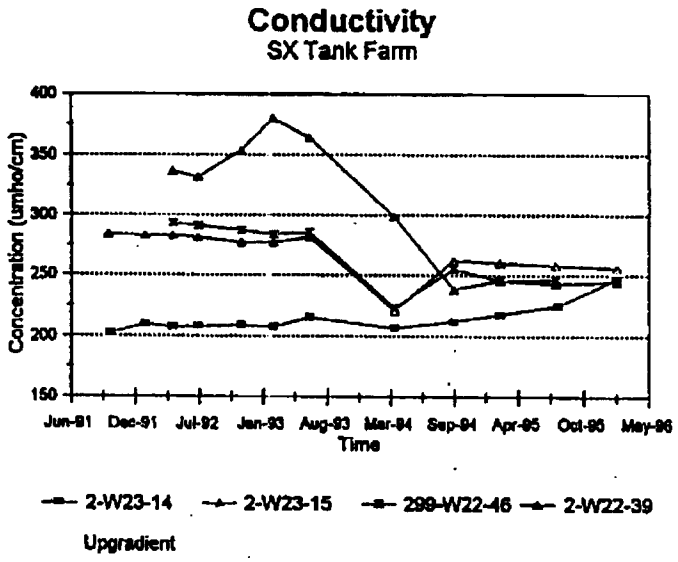


Figure 8. Time Series Plot of Selected Constituents for WMA S-SX.



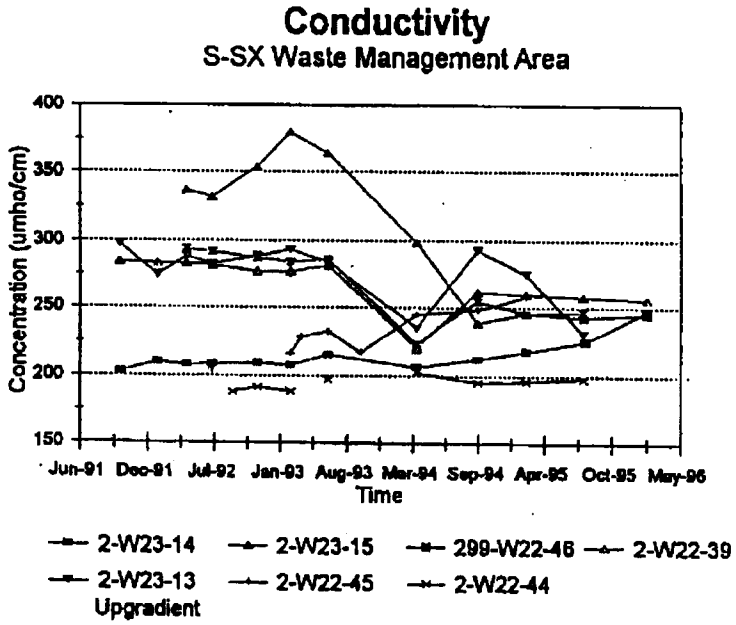


Figure 9. Time Series Plot of Specific Conductance for WMA S-SX.

Older wells that do not comply with these specifications could be used to collect supplemental information (e.g., water levels, radionuclides). Six older groundwater monitoring wells constructed of carbon steel casing that is perforated to communicate with the aquifer exist within the perimeter fence of WMA S-SX. Groundwater in these wells has been sampled by the Environmental Surveillance and other programs and it is in these wells that ^{99}Tc has been found at levels substantially above the 900 pCi/L DWS. Most of the data used to interpret a plume of ^{99}Tc beneath WMA S-SX have come from sampling of these older wells, which are located closer to the SSTs. Groupings based on different ratios of $^{99}Tc/U$ and/or $^{3}H/U$ suggest fractionation of the waste stream that is not related to groundwater flow and transport, but that is mirrored in the fractionation of the waste during waste management operations at the source (refer to discussion in Appendix B). These differences in waste emanating as supernate from tanks and discharged to surrounding cribs appear to match similar compositions in groundwater suggesting that both the SSTs as well as the surrounding cribs have impacted groundwater quality beneath WMA S-SX.

5.0 APPROACH

A two-phased DQO approach was chosen for purposes of defining data needs and associated field work plans. The DQO process is a systematic, cost-efficient approach to ensure that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended use. This process involves the following general steps: (1) State the problem, (2) identify the decision to be made, (3) identify the inputs to the decision, (4) define the study boundaries, (5) develop a decision rule, (6) specify limits on decision errors (if applicable), and (7) optimize design for data acquisition. Key elements of the DQO process as applied for this assessment plan are discussed in the following sections.

5.1 STATEMENT OF PROBLEM AND CONCEPTUAL MODEL

As previously discussed, the occurrence and distribution pattern of SST related waste constituents in groundwater beneath the S-SX Tank Farms provides circumstantial evidence that a pathway to groundwater for migration of mobile contaminants from the WMA S-SX could exist. If the regulated unit is responsible, the pathways and driving force must be identified and appropriate corrective measures taken to prevent any further degradation of groundwater quality. A conceptual model of possible pathways (Appendix B) based on the following available information.

A schematic illustration of hypothesized preferential pathways to groundwater is shown in Figure 3. This diagram illustrates a direct pathway to groundwater through old unsealed wells located within the fenced area of the S-SX Tank Farms. Other more circuitous pathways, such as along clastic dikes, would involve selective separation of the more mobile constituents from the less mobile. This is a variation of interstitial infiltration and more

general movement through the unsaturated zone sediments (discussed in Appendix B, Figure B-4).

If a short circuit to groundwater via an old previously unsealed well exists, cesium-137 should still be detectable in the aquifer immediately adjacent to the borehole. Thus spectral gamma logging should be capable of detecting the presence of cesium-137. In addition, cesium-137 and strontium-90 should be detectable in water samples from a monitoring well that served as conduit or preferential pathway. If conduits involving a clastic dike are involved, or general spreading via interstitial infiltration through the bulk of the soil column occurs, it is likely that most of the strontium and cesium would be retained in the finer textured materials and only the mobile constituents would reach groundwater. Also, as suggested in Figure B-4, a driving force consisting of natural or small amounts of continuous artificial drainage (i.e., unsaturated flow) would result in a relatively shallow depth distribution of contaminants in the uppermost unconfined aquifer and would tend to result in a more or less continuous supply of contaminant. A random event involving extreme run-off that travels into an adjacent unsealed well would be more likely to result in a greater depth distribution of contaminant in the aquifer. The occurrences of contaminant in the aquifer also would be more sporadic in the latter case.

Thus, as noted, any viable transport mechanism involving the WMA S-SX as a source also must account for apparent transient or pulse occurrences of ^{99}Tc and related co-contaminants in several groundwater monitoring wells immediately adjacent to or within the WMA S-SX. Possible driving forces that could occur randomly include (1) intermittent leaking underground utility lines that could have created subsurface discharges, (2) lateral migration from adjacent intermittent sources of wastewater, or (3) surface water run-off and infiltration of natural and artificial sources over the tank farms. Another possibility is that a pulse input occurred in the most northerly well location (refer to Figure B-6) and moved approximately downgradient to the other wells.

5.2 DECISION TO BE MADE

The primary question to be addressed during the Phase I investigation is, as depicted in Figure 2, "Did the mobile contaminants that appear in groundwater beneath and downgradient from the WMA S-SX come from a SST or associated waste facilities?" If the answer to this question is "no", the RCRA monitoring program should revert back to detection monitoring mode. If "yes", a more detailed investigation and assessment plan is indicated and consideration of potentially extensive corrective measures could be initiated (e.g., removal of gravel cover or application of fine textured soil and vegetative cover, or pavement of the entire surface of the tank farms). However, another possible variant on a "yes" answer to this question is that while the regulated unit was responsible for the groundwater contamination, it was a transient occurrence that has passed and no further study is warranted at this time. If so, monitoring would revert back to detection monitoring but include operational precautions or institutional controls (check/repair water line leaks, surface water control, etc.).

5.3 INPUTS TO DECISION

Because it is not possible to physically verify whether or not a pathway to groundwater exists, indirect information consistent with a WMA S-SX source and pathway are needed. The general types of input were indicated in the summary of the conceptual model discussed in Section 5.1 and in Appendix B.

5.4 STUDY BOUNDARIES

The spatial domain for purposes of this assessment is limited to the WMA S-SX and the immediate area surrounding this RCRA TSD unit. Existing supporting information on a larger scale will be supplemented with limited additional work for the phase I investigation.

5.5 DECISION RULE

Very often this step involves development of a statistically based rule that leads to acceptance or rejection of multiple working hypotheses. An example of a statistical based decision rule is the background critical mean for the indicator parameters used during the detection mode. If the critical mean is exceeded, then the regulated unit is assumed to be responsible for the groundwater contamination. Because this condition is already triggered, the followup confirmatory evaluation must rely on more subjective parameters (or a non-probablistic or qualitative DQO approach).

For purposes of this plan, the "decision rule" step will be applied in the form of a logic diagram. An example of this approach is shown in Figure 10. The decision tree or logic diagram can be revised as new information is obtained.

Figure 10 illustrates how the data and/or information will be used in the decision-making process as well as the consequences of the decision or conclusion reached. There are two primary outcomes or decisions to be made: (1) to let the regulated unit revert back to detection monitoring mode, or (2) to initiate Phase II assessment involving a more detailed or intensive investigation. In the latter case, large-scale and expensive corrective measures could be involved (e.g., correction of the gravel cover over the tank farm, rerouting water utility lines, etc.). Thus a higher degree of assurance is needed before resources can be committed. Regardless of which of the two major decisions are made, surface water control around the tank farm and repair of any leaking water lines detected will be accomplished as a matter of good tank farm management practices.

The last two steps (step 6 and 7) of the DQO process are related to a quantitative DQO process and are not applicable for this plan.

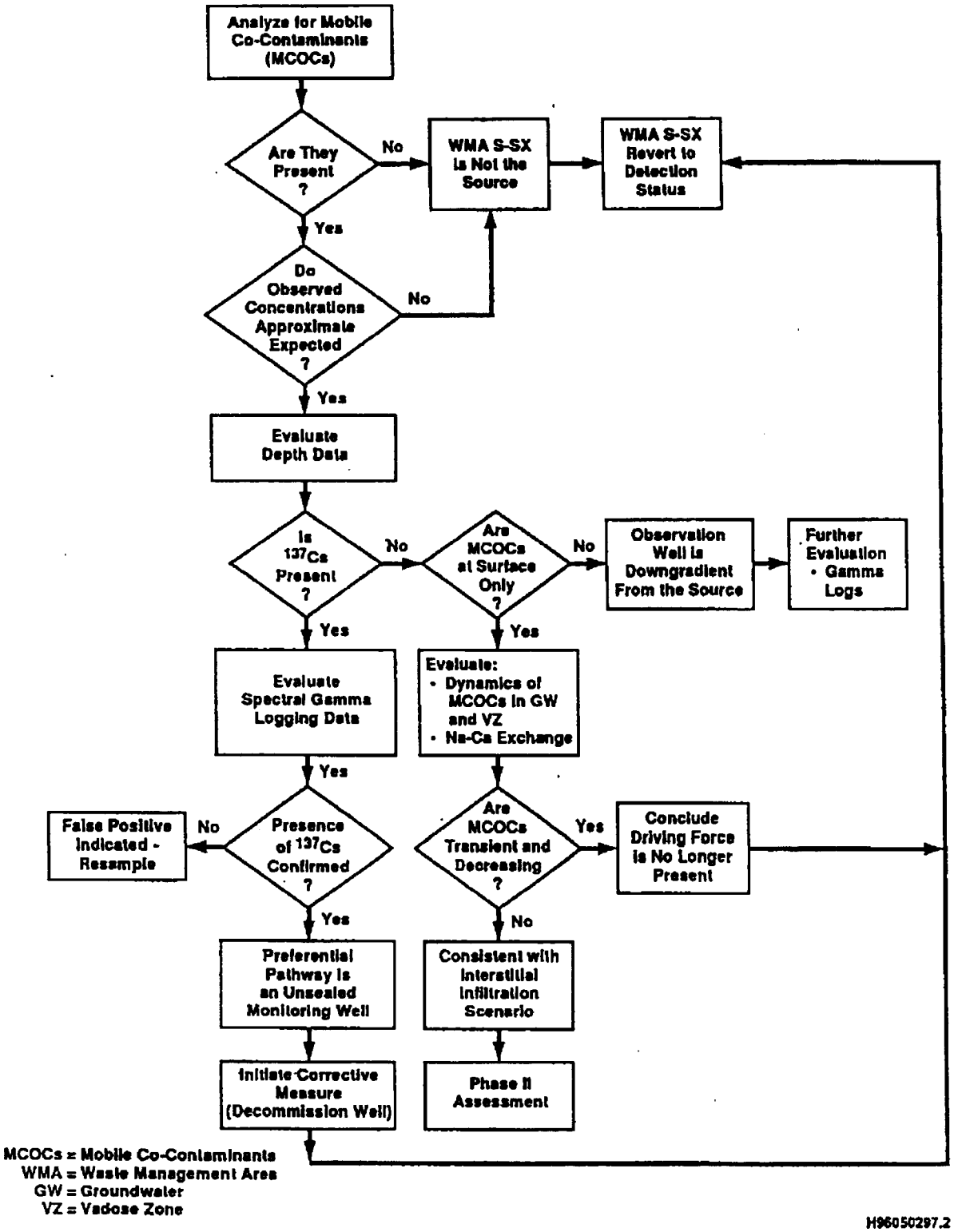


Figure 10. Logic Diagram for Phase I Decision Making Process.

6.0 METHODS

As indicated in Figure 2, the proposed approach will rely primarily on the following:

- Evaluation and correlation of existing SST chemical and radiochemical analytical data and related chemical modeling results
- Supplemental measurements of selected constituents and geochemical indicators in groundwater
- Spectral gamma logging of the unsaturated and saturated zone of groundwater monitoring wells located inside the S and SX Tank Farms.

Detailed task descriptions, rationale, scope, etc., associated with acquisition of the data needed to address the questions/decision rules are listed in Table 2.

Tasks initially are targeted at identifying hypothetical pathways from the source to groundwater and potential forces that would drive contaminants deeper into the vadose zone and to groundwater (Figure 3). Recommendations to improve tank farm operations so as to minimize infiltration and contaminant mobility could result from these investigations.

As stated earlier, the approach to be used employs two phases: (1) the initial Phase I 3-month program is intended to confirm whether tank contaminants have reached groundwater (i.e., whether the contaminants in groundwater are a 'false positive'). At the conclusion of Phase I, a decision will be reached as to whether the evidence supports tank waste reaching groundwater, and if so, a Phase II investigation to determine the magnitude and extent of contamination in groundwater will follow. If, after Phase I, tank waste has been determined not to have reached groundwater, the RCRA monitoring program will revert to detection monitoring and continue as specified in the groundwater monitoring plan. If Phase II is implemented, groundwater quality assessment monitoring will continue and a detailed plan of investigation for Phase II will follow (contingent upon the results of the Phase I investigation).

6.1 PHASE I TASKS

An assessment of the possible impact of SSTs on groundwater quality beneath and in the vicinity of WMA S-SX will necessitate an examination of the following: (1) waste handling and treatment processes (especially any fractionation of the waste into components that were discharged to different types of facilities), (2) interactions of the waste with the soil during interstitial infiltration, (3) enhancements to recharge through waste management/operational practices, (4) identification and determination of effects of preferential pathways on fluid flow and waste transport, and (5) synergistic effects of (1) through (4) on movement of waste through the vadose zone. The objectives will be to: (1) refine conceptual model(s) of

Table 2. Proposed Tasks for Phase I Determinations (DQO-Based Approach).

Task	Subtask	Rationale	Scope	Intended Use of and/or Decisions to be Made With Data
A. Existing Data Evaluation	1. Detailed stratigraphy	To understand the movement of waste-bearing fluids through the vadose zone to groundwater	limited to the 6 RCRA boreholes for the S-SX WMA	Input to modelling of fate and transport of contaminants
	2. Driving force evaluation	Identify potential driving forces	Map present and past utility lines, waste distribution lines, & diversion boxes in S-SX WMA Examine operation/ maintenance records for leaks, duration, and timing Transport Modelling (sensitivity analysis)	Input to determine whether waste from the S-SX WMA is reaching groundwater Input for proposing interim corrective measure(s), if necessary
	3. Co-contaminants Analyses: · Time series plots · Areal map of excess calcium plus magnesium and chromate · Source term evaluation	Correlate groundwater with source term	Selected groundwater monitoring wells (2-W23-15, 2-W22-39, and 2-W22-46) Selected groundwater monitoring wells in the vicinity of S-SX WMA Tanks within the S-SX WMA	Input to determine if waste from the S-SX WMA is reaching groundwater

Table 2. Proposed Tasks for Phase I Determinations (DQO-Based Approach).

Task	Subtask	Rationale	Scope	Intended Use of and/or Decisions to be Made With Data
B. Supplemental Groundwater Measurements	1. Sampling and Analysis of:		One round sampling at:	Input to determine if waste from the S-SX WMA is reaching groundwater
	· Radionuclides (^{137}Cs, ^{90}Sr, and ^{99}Tc)	Correlation of groundwater with source term	2-W23-1, 2-W23-2, and 2-W23-3	
	· ICP-MS (MoO_4^{2-} & RuO_4^{-})[b], CrO_4^{2-} ^{3}H, ^{99}Tc, & anions	Co-contaminants Analysis	2-W23-14[a], 2-W23-15[a], 2-W22-39[a], and 2-W22-45[a]	Source identification
	· Geochemical indicators (pH, conductivity, Eh, dissolved oxygen, and alkalinity)	Understand contaminant mobility	All wells that are to be sampled	Understand contaminant mobility
	· Volatile organic compounds (chloroform)	Identify driving force	Selected RCRA and non-RCRA wells	Input to determine if waste from the S-SX WMA is reaching groundwater
	2. Groundwater flow direction and velocity	To determine groundwater flow direction	2-W23-14, 2-W23-13, 2-W22-46, 2-W22-44, and 2-W23-15	Input to determine if waste from the S-SX WMA is reaching groundwater

Table 2. Proposed Tasks for Phase I Determinations (DQO-Based Approach).

Task	Subtask	Rationale	Scope	Intended Use of and/or Decisions to be Made With Data
C. Borehole gamma logging	Spectral gamma logging in the vadose zone and saturated zone	Pathway identification	20 ft above and below the static water level at 2-W23-1/2-W23-12, 2-W23-2, 2-W23-3, 2-W23-5, and 2-W23-7	Preferential pathway evaluation

[a]at 1, 2, 4, 8, 10, 12, and 14 ft below static water level. [Note: Field screening for nitrate and chromate will be used to determine which discrete depth samples are submitted for the more detailed chemical and isotopic analyses.]

[b]stable fission product isotopes of Ru and Mo.

waste migration, (2) identify possible waste sources and factors increasing the mobility of waste in the soil, and (3) recommend corrective measures if needed. Tracking of the waste from sources to groundwater will allow an assessment of any impacts to groundwater quality from waste that has advertently or inadvertently escaped containment.

Three major tasks are proposed for Phase I:

- Evaluation and correlation of existing groundwater and SST chemical and radiochemical analytical data using radionuclide and chemical constituent ratios and related transport modelling
- Supplemental measurements of selected constituents and geochemical indicators in groundwater
- Spectral gamma logging results of the saturated and unsaturated zone of groundwater monitoring wells located inside the S and SX Tank Farms.

The proposed tasks, described in more detail as follows, are based on the assumption that adequate funding will be available for their completion.

6.1.1 Existing Data Evaluation

This task consists of three subtasks: (1) determination of a detailed stratigraphy of units in the vadose zone along with physical and chemical properties; (2) identification and, to the extent possible, quantification of potential forces that could drive contaminants to groundwater; and (3) identification and analysis of contaminant populations in groundwater.

Detailed Stratigraphy. (as input to the modeling of fluid and contaminant transport)

- Proposed Activities

  The areal extent and geometry of various stratigraphic horizons and their physical and chemical properties significantly influence the movement of waste-bearing fluids through the vadose zone to groundwater. Given the significance of a detailed stratigraphy to fluid flow and waste transport, the following are proposed to develop a detailed stratigraphy for input to a detailed conceptual (and possibly numerical) model:

  - Examine available cuttings, samples, geologic and geophysical logs (including gross gamma as well as spectral gamma K-U-T [potassium, uranium, thorium]) logs to enable correlation of strata between and among boreholes to develop a detailed stratigraphic model. Logs of the six RCRA wells (supplemented by observation of cuttings etc.) will be input to an electronic database to allow data reduction (for preparation of cross sections and isopach and structure contour maps of significant horizons).

- To the extent possible, develop moisture and calcium carbonate profiles for vadose zone sediments using available data from RCRA well construction and geologic logs supplemented by other available data. Calcium carbonate may serve as a 'sink' for ^{90}Sr (by Sr replacement of Ca in the calcite).

- Deliverable

  Detailed geologic cross sections to provide a three dimensional portrayal of the subsurface stratigraphy will be prepared. Isopach and structure contour maps will also be prepared for significant strata that are important to fluid flow and transport. Cross-sections will be prepared on a base that allows plotting of contaminant data from spectral gamma logging. These maps and cross-sections can in turn be used as input to any numerical computer models for future modeling of the fate and transport of contaminants and are vehicles to test various operational options relating to cover materials, repair/replacement of leaking underground pipes and utility lines etc.

Driving Force Evaluation. This subtask is needed to identify potential driving forces that transport contaminants to groundwater.

- Proposed Activity

  Compile maps of underground raw water lines and tanks in and around WMA S-SX that could have leaked fluid to the soils. Examine operating records to determine whether any leaks occurred, the duration of the leak, any estimated leakage, and when any waterline leaks were repaired. This task also includes a review of historical gross gamma logs over time to look for evidence of movement (increasing gamma activity with time). The location of boreholes for which changes are found will be included as an overlay to utility line maps, and the timing of any changes will be correlated with dynamics noted in groundwater monitoring wells.

- Deliverable

  Maps of underground fluid distribution lines on same scale as base maps of WMA S-SX (and surrounding cribs, french drains etc.) and a table documenting estimated leak volumes and repair dates. Map of affected areas (leaks, spills) also will be prepared to the extent possible.

Enhancement of Natural Recharge by Construction/Waste Management Practices. Natural recharge has been enhanced by the construction of the tanks, the location and construction of unsealed dry wells and groundwater monitoring wells, the armoring of the tank farm surfaces with gravel to control vegetation and animal burrowing, and the application of water to the ground for dust control and other practices. Lysimeter studies by Gee (and others) demonstrate the effects of such practices. This investigation will be conducted as part of the vadose zone investigation under the supervision of DOE's Issue Management Team. Results of this activity (transport modelling or

sensitivity analysis) will be integrated into other discoveries/investigations as part of this assessment monitoring plan.

Co-contaminant Analyses. This subtask is needed to correlate groundwater quality with the source term. The following proposed activities are designed to address the question "Do co-contaminants in groundwater occur together and in the right proportions?" (refer to Section 5.5)

- Proposed Activities

  Time series plots of mobile constituents from the tank waste (e.g., tritium, technetium-99, nitrate, chromate, etc.) will be prepared for several selected groundwater monitoring wells (299-W23-15, 299-W22-39, and 299-W22-46). Contaminant plume maps will be generated using available data for wells in and around WMA S-SX in the southern part of the 200 West area. Maps of excess calcium plus magnesium and chromate will be prepared to determine any changes in the pattern of contaminant distribution and what this distribution might reveal about changing hydrogeologic conditions and contaminant distribution/decay. The contaminant populations and areal distribution will be compared with the chemical characteristics of the source waste and any fractionation thereof to determine whether any correlation(s) exist.

- Deliverable

  Time series plots and co-contaminant plume maps at the same scale as maps of facilities in and around WMA S-SX, and possibly at smaller scale to show contaminant distribution patterns in the southern part of the 200 West Area at present and how these distribution patterns might have changed with time.

6.1.2 Supplemental Groundwater Measurements

This task will involve sampling and analysis of groundwater in selected wells (at multiple depths) adjacent to the WMA S-SX for geochemical indicators (Eh, pH, dissolved oxygen) and selected constituents not available in the current groundwater database. The following proposed activities are designed to address the question "Do co-contaminants occur uniformly with depth in the aquifer or are they significantly higher at the water table?" (refer to Section 5.5 for detail).

Groundwater Sampling and Analysis

- Proposed Activity

  The RCRA groundwater monitoring network for WMA S-SX will be expanded to include more wells in and around the 241-S and 241-SX Tank Farms if necessary. A fitness-for-use evaluation will be performed on older wells in and around WMA S-SX to include the wells inside the perimeter fence and older crib monitoring wells both up and downgradient of WMA S-SX. If suitable and selected for the expanded network, all

wells selected in the expanded network (including the normally sampled RCRA wells) will be remediated as necessary. One round of sampling will be conducted for: (1) low range ^{137}Cs, ^{99}Tc, ^{90}Sr in three wells (299-W23-1, 299-W23-2, and 299-W23-3) located within the S and SX Tank Farms; (2) analysis of groundwater samples for mobile trace metal constituents (e.g., Cr and isotopes of Ru and Mo) known or predicted to be present in tank waste using ICP-MS methods, anions, and alkalinity in wells 299-W23-14, 299-W23-15, 299-W22-39, and 299-W22-45; (3) geochemical indicators (pH, specific conductance, Eh, dissolved oxygen); and VOAs (to detect chloroform--a breakdown product of chlorine from sanitary water). Chloroform also is a degradation product of carbon tetrachloride which is not present in groundwater beneath the SX Tank Farm. Where appropriate, samples will be obtained from multiple depths within a well to determine depth distribution as a means of testing hypotheses of driving mechanisms. Samples for metals and radionuclide analyses will be filtered. Sample collection, handling, transportation, and analyses will follow standard protocols as employed for RCRA sampling and analyses. More details regarding sampling can be found in Table 2.

- Deliverable

  Data will be entered into HEIS and GeoDAT following the usual RCRA protocol. Tables summarizing all or parts of the data could be included in the assessment report. Maps and plots of concentration/activity vs. time may be employed for the assessment report as deemed necessary.

Groundwater Flow Direction & Velocity

- Proposed Activity

  Contaminant plume maps suggest groundwater flow directions could depart from predicted directions based on water table maps. If so, upgradient wells might not be representative of background conditions. Therefore, water level data anda water table maps, together with hydraulic conductivity maps, will be re-examined for expected flow direction and contaminant distribution. To the extent possible, the borehole velocity flowmeter will be run in key wells to determine actual direction of groundwater flow in particular wells at different levels in the well screen. Data on groundwater flow direction and velocity will be used to compare with the pattern of contaminant distribution and changes in the distribution patterns with time.

- Deliverable

  Tables and plots illustrating the interpretation of groundwater flow velocity will be prepared for the assessment report. Any differences in the direction of flow with depth in the screens also will be plotted to determine whether any changes in flow direction might help explain the distribution of contaminants.

6.1.3 Borehole Gamma Logging

Spectral gamma logging of five boreholes (inside the Tank Farm fenceline) covering at least 20 feet above and below the static water level will be conducted for pathway identification.

Geophysical Logging of the Deep Vadose Zone

- Proposed Activity

  RUST Geotech has performed spectral gamma logging in the boreholes (dry wells) surrounding the 15 tanks in the 241-SX Tank Farm. The deepest borehole is 125 feet; the water table is approximately 210 to 215 feet below ground surface. Spectral geophysical logging will be performed in the five groundwater monitoring wells inside WMA S-SX to provide data on gamma-emitting contaminants in the deeper part of the vadose zone (between 125 feet and groundwater). Logging tools and speeds will be comparable to those employed by RUST so that the resulting data can be compared with the spectral gamma logs obtained by RUST. The objective will be to determine the maximum depth of penetration of gamma-emitting contaminants (mostly ^{137}Cs) in the five carbon steel groundwater monitoring wells inside the perimeter fence of WMA S-SX (assuming that a pre-logging evaluation and inspection finds that the wells are in a condition that can be successfully logged). Data will be analyzed to the extent possible to determine whether contaminants are adhered to the casing or soils within the annular space or are distributed throughout the formation (i.e., an evaluation of preferential pathway versus interstitial infiltration).

- Deliverable

  Spectral gamma logs of gamma emitting contaminants and naturally occurring isotopes (^{40}K, U, Th) and a report of the detailed logging procedure will be prepared. Results will be used to refine conceptual model(s) concerning the transport mechanism of uncontained waste.

Spectral Gamma Logging in the Saturated Zone

- Proposed Activity

  Spectral gamma logging using the RLS will be conducted in wells where well construction permits the acquisition of reasonable and quantifiable data. The logging tool will be run in the vadose as well as saturated zones. In the saturated zone, the intent will be to determine whether and what amount of gamma-emitting contaminants (esp. ^{137}Cs) are present that are strongly sorbed or in solid form such that these are not soluble and can not be sampled by groundwater sampling and analysis.

- Deliverable

  Spectral gamma logs of wells logged into the saturated zone will be produced. Furthermore, the areal distribution of gamma-emitting contaminants in the aquifer will be plotted and contoured to the extent possible to determine whether there are zones of greater concentration that might suggest source facilities from which the contaminants may have emanated.

6.2 QUALITY ASSURANCE PROGRAM

Groundwater sampling procedures, sample collection documentation, and *chain-of-custody* requirements are described in *Environmental Investigation Instructions* (EII) (WHC-CM-7-7) and in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1995). Work by subcontractors will be conducted to their equivalent approved standard operating procedures.

6.2.1 Sampling Procedures

All field sampling activities will be recorded in the proper field logbook as specified in EII 1.5 and subsequent revisions (WHC-CM-7-7). Before sampling each well, the static water level will be measured and recorded as specified in EII 10.2. Based on the measured water level and well construction details, the volume of water in the well will be calculated and documented on the well sampling form or field notebook. Each well will be purged until the approved criteria are met, as specified in EII 5.8. Purgewater will be managed according to EII 10.3. If a well pumps dry because of very slow recharge or low water levels, samples will be collected after recharge.

Overall quality assurance (QA) program requirements are defined by *Westinghouse Quality Assurance Manual* (WHC-CM-4-2) and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996). The RCRA sampling and analysis program is supported by WHC (1995). Sample preservation and chain-of-custody procedures are discussed in EII 5.1 (WHC-CM-7-7).

6.2.2 Analytical procedures

Procedures for field measurements (e.g., pH, conductivity, etc.) are specified in the user's manuals for the meters used. Laboratory analytical procedures are specified in WHC (1995) or its most recent revision. Most of the analytical methods are selected from those provided in *Test Methods for Evaluating Solid Wastes* (EPA 1992). For constituents with no analytical method specified by EPA (1992), other methods are selected as specified by WHC (1995).

6.3 PHASE I REPORT

After completing the Phase I investigation, all data (deliverable products identified previously) will be compiled, analyzed, interpreted, and reported in a Phase I assessment report. The objective will be to determine whether the SSTs in WMA S-SX could have had any significant effect on groundwater quality. If the SSTs in WMA S-SX have had no impact on groundwater quality, the site will return to interim status detection-level monitoring. If the analysis indicates that groundwater could have been impacted, a Phase II investigation will be planned and implemented contingent on the results of the Phase I investigation. Phase II, if needed, would likely expand on the investigations conducted for Phase I to provide additional information/data for a more complete analysis. Phase II investigations would be incorporated into TWRS characterization of the nature and extent of waste in the vadose zone beneath the tank farms to facilitate remediation/closure. Data obtained in the Phase I assessment investigation will be used to guide/support operational decisions affecting tank farm operations and the repair/maintenance of utility lines.

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APPENDIX A

LETTER FROM ECOLOGY TO DOE PLACING WMA S-SX INTO ASSESSMENT MONITORING STATUS

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Rec'd 5/29/96 11:25 am

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1315 W. 4th Avenue • Kennewick, Washington 99336-6018 • (509) 735-7581

May 24, 1996

Mr. K. M. Thompson
U.S. Department of Energy
P. O. Box 550
Richland, WA 99352

Dear Mr. Thompson:

The Washington State Department of Ecology (Ecology) has recently completed an evaluation of the RCRA groundwater monitoring systems for the S and SX tank farms, as described by the *Interim Status Groundwater Monitoring Plan for the Single Shell Tanks*, WHC-SD-EN-AP-012. The evaluation was conducted to determine if there was a common source for the cesium-137 discovered in the vadose zone at depths ranging 60 to 125 feet below land surface (BLS) at the SX tank farm, and high concentrations of technecium-99 (^{99}Tc) in the groundwater below and downgradient of the S and SX tank farms. The evaluation encompassed all groundwater data in the vicinity of the tank farms and surrounding liquid disposal facilities, and included a review of the procedures used in determining the existence of statistically significant differences in the concentrations of contamination indicator parameters (CIPs), between background and downgradient wells. CIPs include conductivity, pH, total organic carbon (TOC), and total organic halogens (TOX).

After a thorough analysis of all available data, Ecology has concluded the overwhelming preponderance of evidence points to the tank farms as having contaminated the groundwater with ^{99}Tc. The groundwater monitoring system has, therefore, been determined unable to "immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer," as required by Washington's Dangerous Waste Regulations WAC 173-303-400 and 40 CFR 265.91 (a) (2), and (b).

The examination of groundwater data included an evaluation of aquifer characteristics and contaminant plume histories for tritium, uranium, gross beta, and ^{99}Tc, creation of trend plots for various radionuclides, estimation of historical ^{99}Tc concentrations from the counting efficiency of gross beta emissions, and calculation and mapping ^{99}Tc/U and tritium/^{99}Tc ratios. Ecology's conclusions from this evaluation are the following: (1) two distinct populations are evident in the ^{99}Tc concentrations; (2) ^{99}Tc concentrations are significantly greater within and downgradient from the S and SX tank farms than up and side gradient of the farms; (3) historical data of gross beta concentrations in the southwest portion of the 200 West Area indicates sources upgradient of the S and SX tank farms do not exist; (4) ^{99}Tc/U ratios are greater within and downgradient of the S and SX tank farms than up and side gradient of the farms, as expected from the potential formation of insoluble uranium phosphate in the tanks; (5) tritium/^{99}Tc ratios are lower beneath the tanks and higher beneath adjacent cribs, as expected from the historical discharge to cribs of tank condensate with high levels of tritium; and (6) no evidence in terms of laterally continuous formations of

low permeability in the vadose zone or groundwater mounds below the cribs exists to support U.S. Department of Energy (USDOE) models for the movement of ^{99}Tc from adjacent cribs to groundwater beneath the S and SX tank farms.

The review of statistical procedures indicates the critical mean for conductivity was calculated from data collected during the first year of monitoring, from both upgradient wells 299-W23-13 and 299-W23-14. Since the conductivity at monitoring well 299-W23-13 has historically been significantly higher than the conductivity at monitoring well 299-W23-14, the critical mean of 486.9 umhos/cm used in the statistical comparison with downgradient wells, is biased by the higher conductivities measured at monitoring well 299-W23-13. The critical mean for conductivity, based on quarterly replicate measurements of samples collected at monitoring well 299-W23-14, is 248.6 umhos/cm. This value has consistently been exceeded in the monitoring wells downgradient of the SX tank farm since 1991, indicating the tank farm has impacted the groundwater, and the monitoring system does not satisfy 40 CFR 265.91, by reference of WAC 173-303-400.

Therefore, based on the conclusion that ^{99}Tc in the groundwater beneath the S and SX tank farms came from the tank farms, the conductivity exceeding the critical mean for conductivity in downgradient wells, and in accordance with the requirements of WAC 173-303-400, and 40 CFR 265.93 (d) (2), USDOE must initiate a groundwater assessment monitoring program for the S and SX tank farms. The specifics of this program, including a thorough explanation of the statistical evaluation methodology, must be detailed in a groundwater monitoring assessment plan per the requirements of 40 CFR 265.93 (d) (3), and submitted to Ecology for review and approval by June 20, 1996.

If you have any questions regarding this letter, please call me at (509) 736-3046.

Sincerely,

Stan Leja
RCRA Hydrogeologist, NWP

SL:mf

cc: Marv Furman, USDOE
Linda McClain, USDOE
Jim Rasmussen, USDOE
Casey Ruud, USDOE
Craig West, USDOE
Doug Sherwood, EPA
Janice Williams, WHC
Merilyn Reeves, Hanford Advisory Board
Administrative Record

APPENDIX B

CONCEPTUAL MODEL DEVELOPMENT

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APPENDIX B

CONCEPTUAL MODEL DEVELOPMENT

1.0 INTRODUCTION

The vadose zone spectral gamma logging results for the S-SX WMA during 1995 suggested that tank farm related contaminants could migrate to greater depths than previously thought. The presence of indicators of tank waste in groundwater (e.g., technetium-99) beneath the S-SX Tank Farm also suggested there could be transport through the vadose zone to groundwater. An occurrence report suggesting this possibility was issued by Westinghouse Hanford Co. for the S-SX WMA.

The conceptual model, based on existing information and/or inferences, is a fundamental step in development of the assessment or test plan. This involves conceptualization of waste migration through the vadose zone to groundwater and is an integral part of the DQO process. The outcome of this effort is used to define the data needs from which test plans and field work plans are developed.

Although the following discussion is focused on the S-SX Tank Farm, similar conditions could exist for other SSTs and related waste handling systems. A review of initial observations is presented first, followed by discussion of the proposed conceptual model of hypothetical contaminant transport through the vadose zone to groundwater beneath the S-SX WMA.

2.0 INITIAL VADOSE ZONE GAMMA LOG AND GROUNDWATER OBSERVATIONS

Initial spectral gamma logging of existing boreholes was conducted in the southern section of the SX Tank Farm where the largest recorded volume of tank-related leaks in the S-SX WMA are known (or suspected) to have occurred. Spectral gamma logs indicated that cesium-137, the most readily detectable SST waste constituent, was present in several boreholes along the southwest side of the SX Tank Farm. Cesium-137 also was detected at the 125 ft depth of several vadose zone monitoring wells in this area of the tank farm.

The initial results, as noted previously, stimulated re-evaluation of existing gross gamma log and groundwater data. The historical gross gamma log data revealed that in addition to the occurrence of gamma emitting radionuclides at greater depths than expected, in at least one vadose well there appeared to be a regular pattern of increasing gamma-ray intensity over time (Figure B-1). This pattern suggested that some type of continuing movement of tank waste in the soil or vadose zone was occurring at this location. Because cesium-137 is expected to migrate more slowly than the more mobile waste constituents (e.g., NO_3^- and TcO_4^-), the preliminary vadose zone

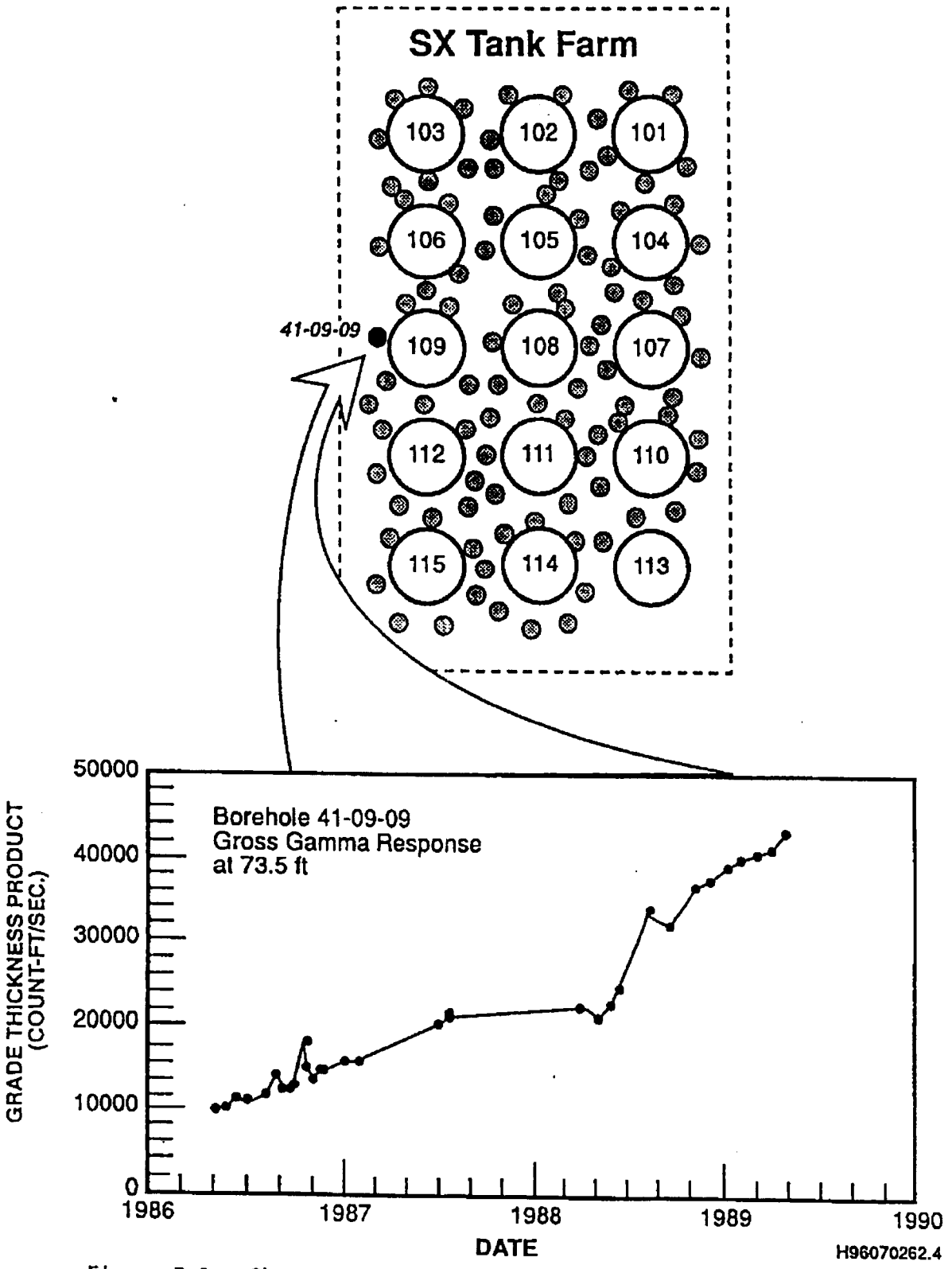


Figure B-1. Change in Gross Gamma-Ray Intensity Versus Time in Borehole 41-09-09 at Tank SX-109.

results suggested the mobile tank waste constituents could be at much greater depths. In addition, the occurrence of an anomalous pattern of Tc/U ratios in groundwater monitoring wells, both within and adjacent to the tank farm, suggested there could be a source from somewhere within the S-SX WMA (Figure B-2). The ratio of these two constituents, both of which are equally mobile in natural waters, should be approximately uniform, regardless of their absolute concentrations, if these are both from the same source. In addition, because fractionations occurred in different waste streams (refer to Appendix E), the magnitude of the ratio should reflect different sources. As indicated in Figure B-2, there is a narrow zone of anomalously high Tc/U ratios immediately beneath the S-SX Tank Farm. The groundwater from adjacent monitoring wells and waste water discharged to cribs surrounding the S-SX Tank Farm have relatively low ratios (average ratios for each adjacent crib are shown in open boxes next to each location as shown in Figure B-2). The Tc/U ratio in water wash fractions of sludge or core samples from the S-104 tank were very high (>300), suggesting that an SST source should have a relatively high Tc/U ratio. The highest ratio in groundwater was 200 and occurred in a well (2-W23-1) located immediately downgradient from the S-104 Tank. The wells with the high Tc/U ratios are also the wells with the highest technetium concentrations.

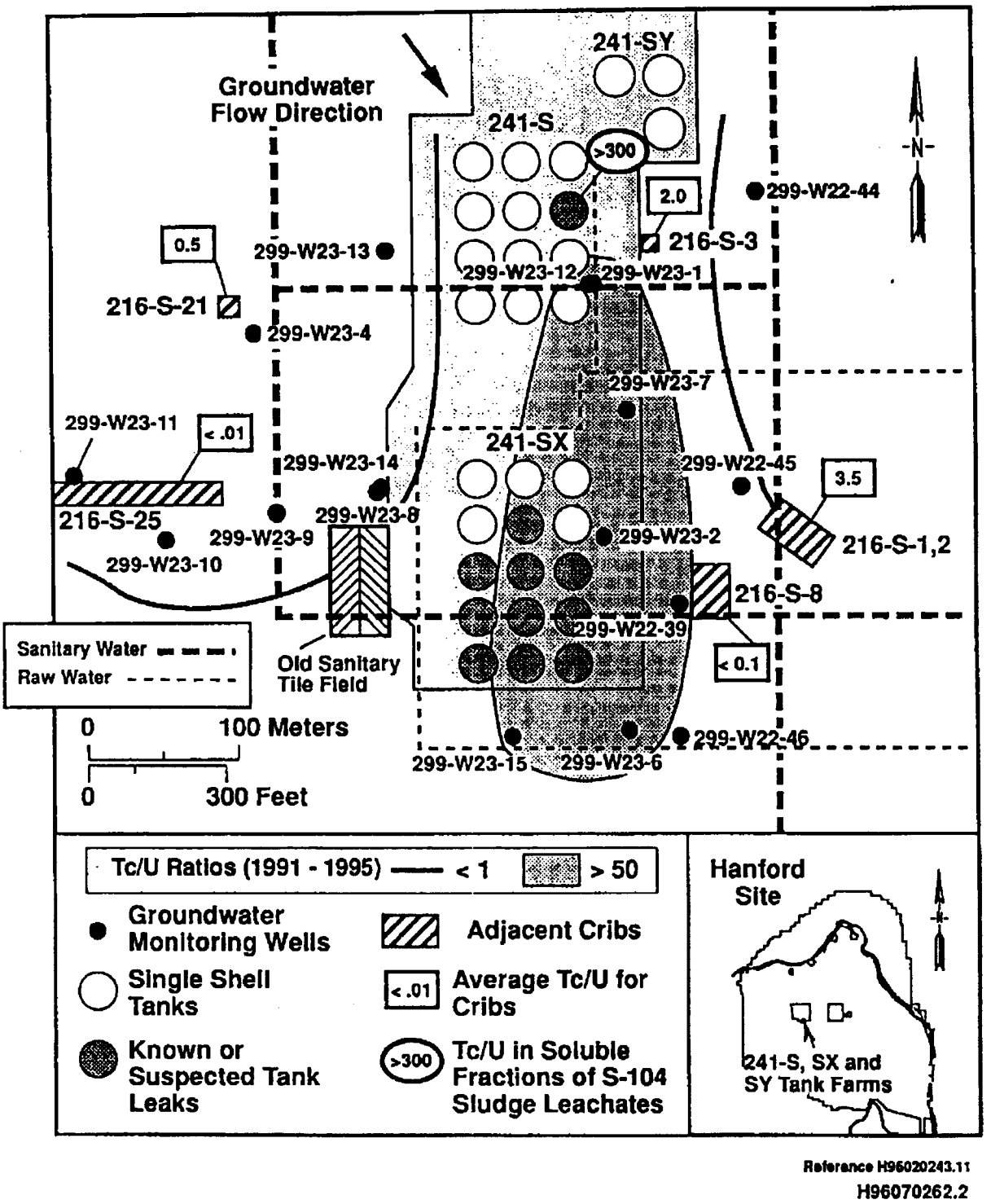
The spectral gamma logging results for the SX Tank Farm indicated there was near-surface contamination approximating the area that includes the 10 tanks with known or suspected leaks in the SX Tank Farm. The highest near-surface soil contamination appeared to be located between the center and the southwest corner of the SX farm. The latter location includes the tanks with the largest known leak volumes (SX-115 and SX-112; refer to Figure B-1 for locations). The highest subsurface contamination appeared to be near the west central area of the SX Tank Farm (i.e., between SX-109 and SX-108).

The identified soil contamination zones noted previously only partially overlap the anomalous Tc/U ratios in groundwater. However, it should be noted that there are no groundwater monitoring wells along the west side of the S-SX WMA. In addition, gamma logging results are not yet interpreted for the S Tank Farm. It should also be noted that distribution lines enter the S-SX Farm from the east side. Leakage from transfer lines and or distribution boxes would thus be more likely to influence groundwater beneath the east side of the S-SX WMA. More information is needed to evaluate source-receptor spatial relationships and soil and groundwater contamination in the S-SX WMA.

Nevertheless, based on available knowledge and expected behavior of mobile constituents the following conceptual model of hypothetical pathways, sources and transport processes is proposed.

3.0 CONCEPTUAL MODEL

The proposed pathways depicted in graphical form are *hypotheses* that can hopefully be tested and thus guide the acquisition of new data. The following discussion and graphics are based on available data. The conceptual model



Reference H96020243.11
H96070262.2

Figure B-2. Technetium/Uranium Ratios in Groundwater and Possible Sources Within and Near the S-SX WMA.

will be revised as new data and related information with which to confirm or reject proposed or hypothetical pathways are acquired.

Mobilization of tank waste constituents is primarily dependent on the nature of the driving force and on the chemical characteristics of the waste, discussed separately as follows.

3.1 PATHWAYS AND DRIVING FORCES

Hypothetical sources and migration pathways beneath the S-SX WMA are illustrated in Figures B-3 and B-4. Pathways that could bypass the normal movement of moisture or liquid through the soil column are indicated in Figure B-3. These are referred to as 'preferential' pathways and could involve both natural features such as 'clastic dikes' or more direct paths along unsealed monitoring wells (five such groundwater wells are located inside the S-SX fenceline, two of which are immediately adjacent to SSTs). Clastic dikes are common in the 200 West Area and consist of silt and sand infillings of variable width that pass vertically through the horizontal sedimentary layers. These features are capable of transmitting liquids more rapidly than the adjacent sediments or soil column through which they pass.

Direct infiltration of natural precipitation also can serve as a driving force (indicated by downward vertical arrows above ground surface). Calculations of natural infiltration rate, which is enhanced because of the coarse gravel cover over the tank farms, suggest an average rate of 10 cm/year or more is possible. This could be greatly enhanced by the run-off from the tank tops and migration of water downward along the outside tank walls. This process could significantly magnify the infiltration rate in the immediate vicinity of tank leaks. The effective infiltration rate due to this process could be several times greater than a uniform areal infiltration rate of 10 cm/yr. Migration of surface water run-off over or through the tank leak sites could be carried into the older unsealed vadose monitoring wells or the adjacent groundwater monitoring wells and thereby provide a more rapid transport to groundwater.

Figures B-3 and B-4 also indicate the possible presence of artificial sources of water from utility lines that could act as a driving force. Corrosion of older iron pipes used for sanitary water and raw water distribution is known to occur on an industry-wide basis. The proximity of such lines to SST farms (refer to Figure B-2) and the periodic water line repairs that occur provide at least circumstantial evidence that potential leaks could have occurred near past tank leak or distribution line locations. Such sources would provide a driving force for movement of waste to groundwater. For example, a sink hole apparently developed in the recent past in the south central area of the S Tank Farm (near S-108 tank) due to leakage from a sanitary water line inside the tank farm. The line causing the sink hole subsequently was taken out of service. If there are no near surface indications of a leak such as a sink hole, a line leak could go undetected for years. However, judging from the dynamic nature of technetium-99 occurrences in the vicinity of the S-SX WMA (Figure B-5), a leaking water line that was

Hypothetical Sources and Potential Pathways to Groundwater in the S-SX Waste Management Area

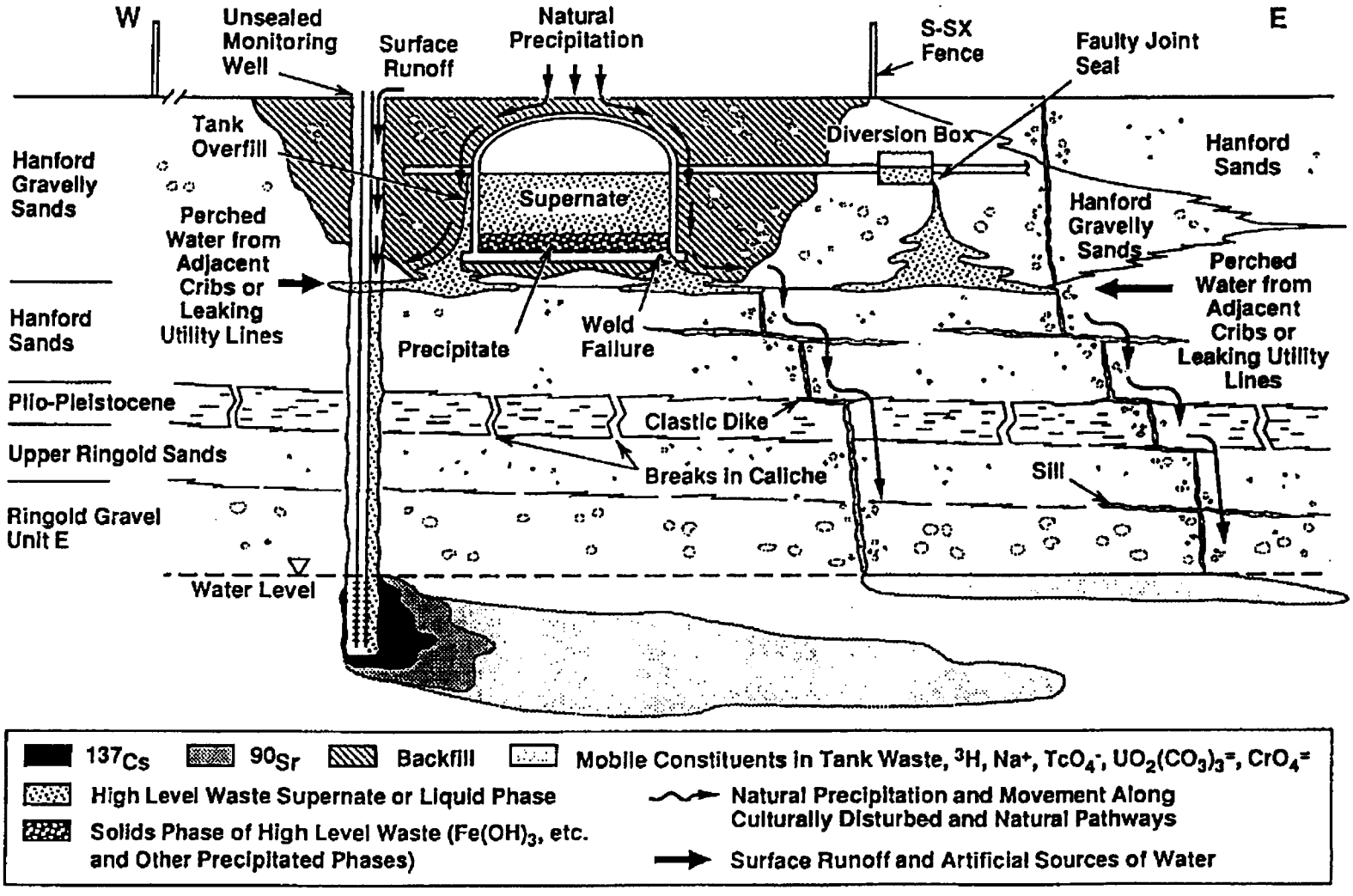


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Figure B-3. Hypothetical Sources and Preferential Pathways to Groundwater.

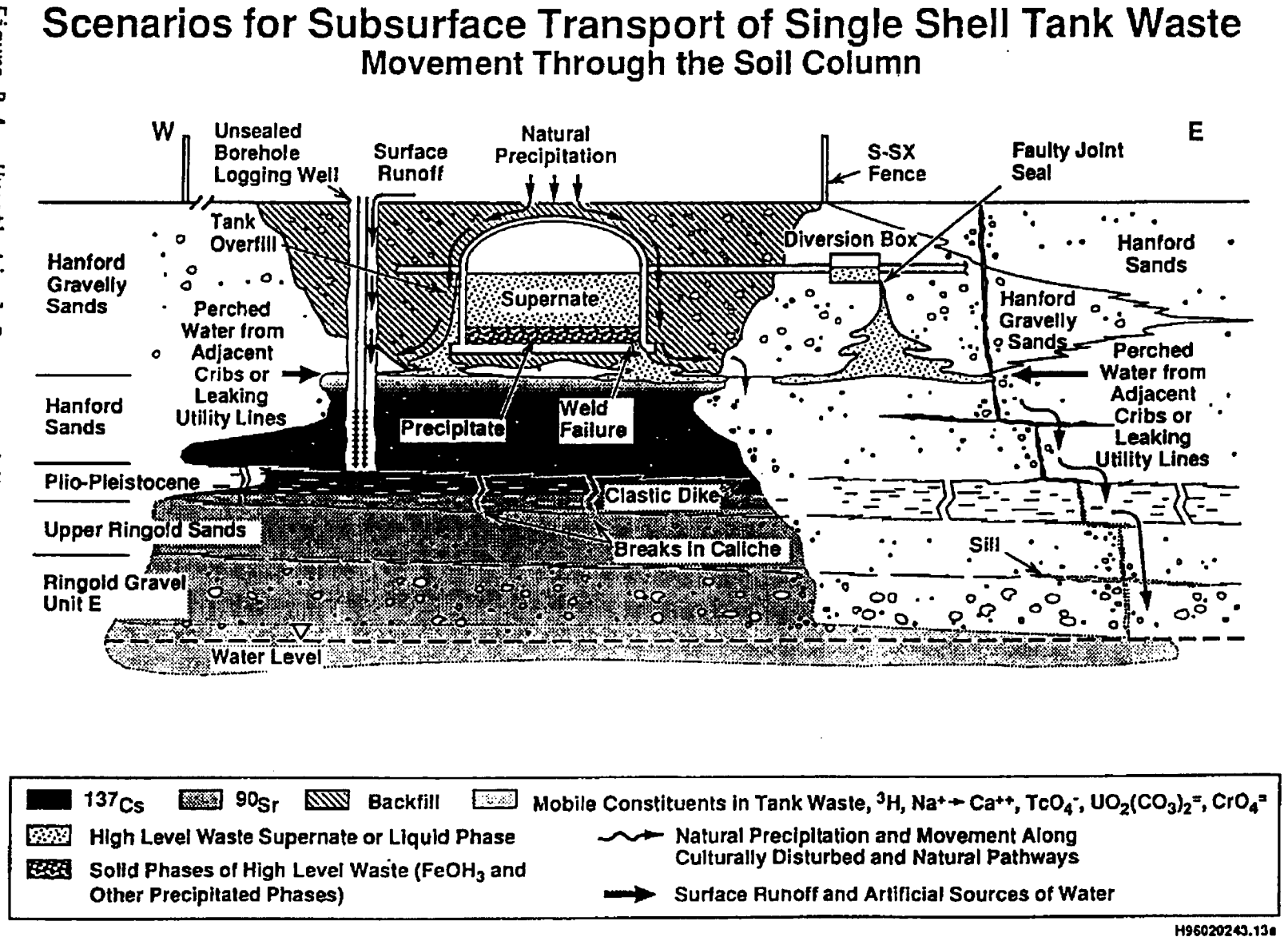


Figure B-4. Hypothetical Sources and Movement Through the Soil Column to Groundwater.

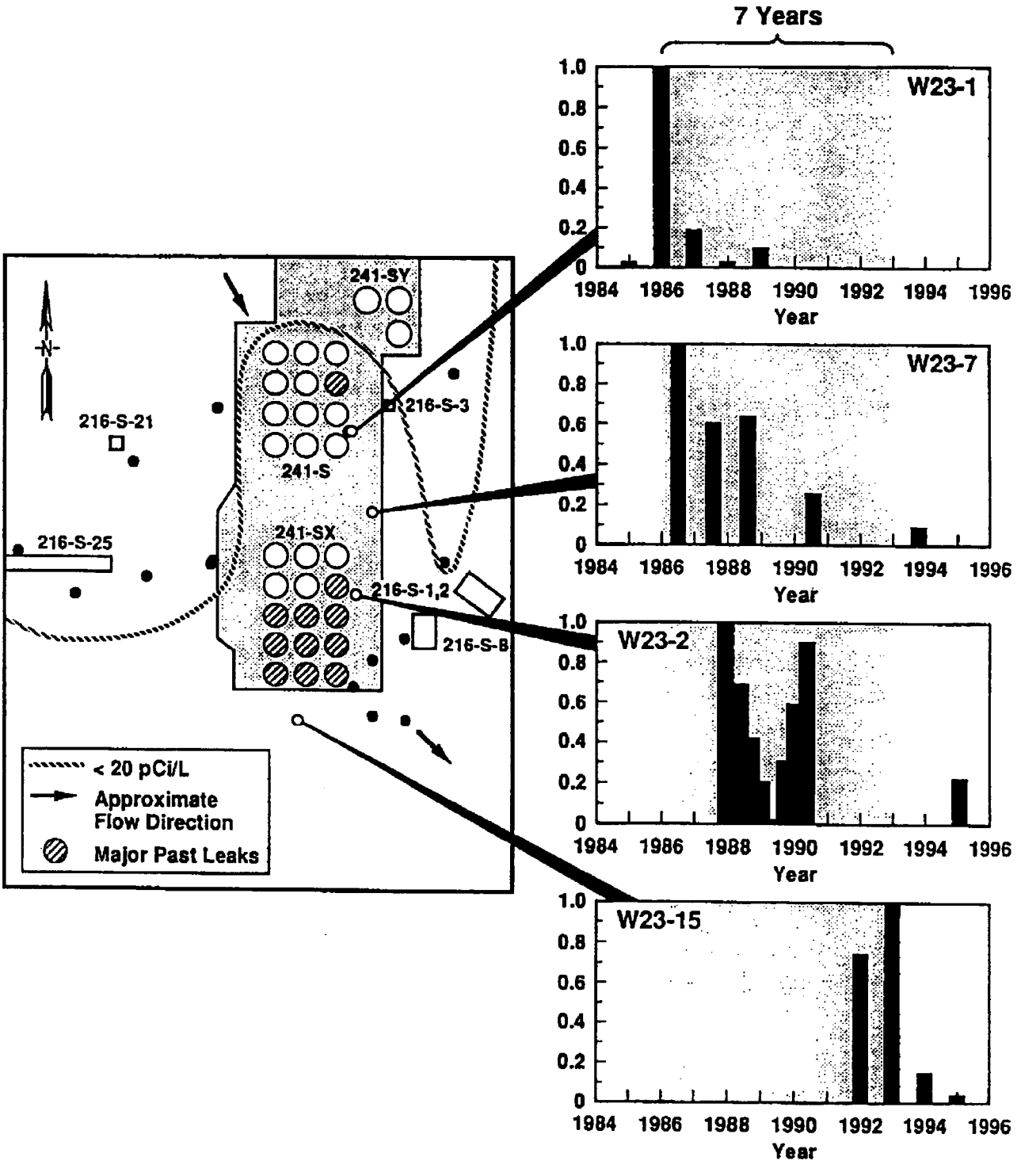


Figure B-5. Relative Technetium-99 Concentration Versus Time Near at the S-SX WMA.

repaired, or a temporary artificial recharge event that subsides, seems more consistent with the observed contaminant responses in monitoring wells.

This, combined with recently discovered water line leaks overlying past waste sites in the 100 K Area, which apparently resulted in transport of strontium-90 to groundwater, suggests utility line leaks could be common at the Hanford Site. The consequences of a water line leak can be significant if it occurs in the vicinity of past practice waste sites, spills, or tank waste leakage.

Older, carbon steel utility lines can leak as a result of either corrosion or electrolysis and/or by freezing. The latter typically occurs at fire plugs during a cold winter. Recent experience at the 200 Area Treated Effluent Disposal Facility adds credence to the idea that the older cast iron water distribution lines at the Hanford Site undergo significant corrosion. For example, during 1995 and spring 1996, periodic elevated iron concentrations occurred in grab samples of effluent discharged to the disposal ponds. This was in part attributed to corrosion of sanitary water lines that had been 'flushed' after a period of non-use. Tens of miles of water distribution lines cross the Hanford Site and many are near or pass over waste sites. Considering the age of most of these lines, leaks are a likely occurrence.

Differentiating Among Possible Pathways. If the mobilized tank waste followed a more direct path to groundwater, most of the fractionation due to different migration rates should seemingly occur in the saturated zone, as indicated in Figure B-3. A more diffuse or distributed pathway through the entire soil column without a preferential pathway would involve fractionation with depth or distance due to differential sorption-desorption reactions as suggested in Figure B-4. In the latter case, there would be more opportunity for ion-exchange reactions to occur between waste constituents in the migrating fluid and the soil. Major cationic waste components such as sodium could be exchanged for the naturally occurring cations present in the soil column, depicted as follows:

$$2\ Na^{+} + Ca,Mg\text{-}[Soil] = Ca^{2+}, Mg^{2+} + 2\ Na\text{-}[Soil]$$

Given enough time (path length) for the exchange process, the replacement could be nearly complete by the time a hypothetical waste/moisture front mixture reaches groundwater. If so, even though sodium is a major chemical constituent in tank waste and is very soluble, there may be little if any present in the waste mixture that reaches groundwater. This process could explain the apparent discrepancy between predicted and observed sodium as discussed in Appendix E (R. J. Serne, personal comm.).

In addition to the above, it should be noted that contaminants that migrate to groundwater under 'unsaturated' flow conditions are more likely to be present at the very top of the aquifer. Contaminants that are transported under saturated conditions such as beneath a crib that receives large volumes of waste water, or via a water-filled groundwater monitoring well, are more likely to be distributed over a greater depth in the aquifer because of the

hydrostatic pressure difference or 'head' created by the column of water (pore fluid in the soil column or water filling the open casing of a monitoring well). The two possible cases are illustrated in the conceptual model scenarios as either a shallow mobile contaminant plume (Figure B-4) or a mobile contaminant plume with a greater depth distribution (e.g., plume associated with monitoring well in Figure B-3). The test parameter in this case is the depth distribution of key constituents. A shallow distribution would suggest the case depicted in Figure B-4. Deeply distributed contaminants would favor the monitoring well preferential pathway, or adjacent crib sources from past-practice disposal operations. Co-contaminant ratios could be used to distinguish between a crib or monitoring well source.

3.2 TANK WASTE CHEMICAL CONSIDERATIONS

The first cycle, aqueous waste stream generated from the REDOX process, was a multimolar sodium nitrate/nitric acid mixture containing sodium dichromate and permanganate to control the oxidation state of plutonium. After extraction of the uranium and plutonium, the concentrated nitric acid process stream was neutralized with sodium hydroxide and routed to the S-SX Tank Farm as "R" waste (Figure B-6). The waste was highly radioactive and generated enough heat to self boil. The vapor, containing most of the tritium generated in the process, was condensed and routed to the adjacent S Cribs (S-3, S-4, and S-21; refer to Figure B-2 for locations). In addition to the in-tank phase separation due to boiling, the high pH resulted in formation of precipitates of metal hydroxides, including uranium. Transfers within the tank farm as well as transfers from other tank farms, included phosphate that very likely contributed to formation of insoluble uranium phosphates within the tanks. Because of the varying chemistry of tank contents, predicting the chemical form of various waste constituents based on mass loading estimates and expected chemistry is difficult at best. A reasonable alternative is to use the relative composition of the easily solubilized fraction of tank sludge samples as an indicator of the mobile constituents, and to indicate the relative amounts that should be expected in receptor media (soil and groundwater).

Both earlier tank sampling efforts as well as more recent tank characterization studies included tanks in the S and SX Tank Farm (TWRSPP-95-021). The water wash fraction of the sludge samples recovered from these tanks consists of water soluble and or mobile constituents as presented in Table B-1.

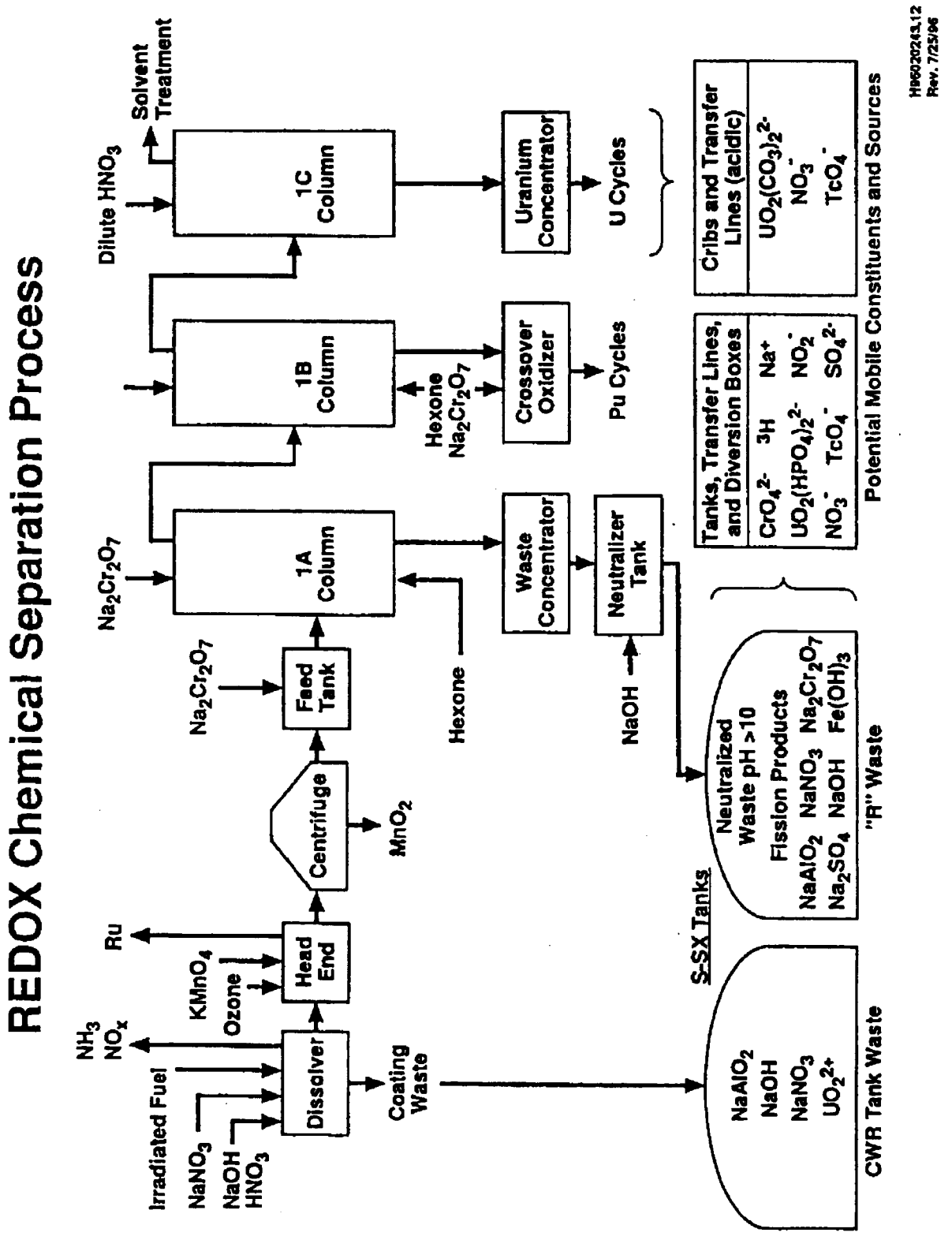


Figure B-6. REDOX Process and Waste Stream Flow Sheet with Expected Mobile Waste Constituents.

Table B-1. Water Soluble and/or Mobile Constituents From S-SX Tank Waste.

Constituent	Expected chemical form	Mobility
Tritium	H_3O	Highly mobile
Technetium-99	TcO_4^-	Highly mobile
Sodium	Na^+	Moderate to high mobility
Nitrate	NO_3^-	Highly mobile
Chromate	CrO_4^{2-}	Highly mobile
Sulfate	SO_4^{2-}	Highly mobile[a]
Aluminate	AlO_2^-	Mobile but analytical problems
Uranium	$(UO_2\ CO_3)_2^{2-}$	Mobile under oxic conditions
Cesium-137	Cs^+	Soluble but not very mobile in soil or sediments
Strontium-90	Sr^{2+}	Moderately mobile in soil or sediments

[a]expected concentrations not high enough above natural background.

Additional potentially useful trace 'markers' include stable isotopes of ruthenium (as RuO_4^-) and molybdenum (as MoO_4^{2-}). The latter have been identified in recent wash fractions of tank waste by ICP-MS methods and are expected to be as mobile as NO_3^-, CrO_4^{2-} and TcO_4^-. The Ru and Mo isotopes are fission products produced in high yield (about the same as Tc) and thus together with technetium-99 may serve as unique markers of first cycle waste. The relative abundances of the three stable isotopes of Ru (101, 102 and 104) also may provide a fingerprint of individual waste streams not resolvable by simple chemical or total element abundance measurements (R. J Serne, pers. comm.).

The dichromate added in the original process stream (Figure B-6) is of particular interest because this should remain as a soluble anionic species even at the high pH in tank waste. At greater dilution, the dichromate may disassociate as follows:

$$Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$$

However, both oxyanions are mobile. Anionic chromium should prevail in tank waste as indicated by the Eh-pH diagram shown in (Figure B-7). Additionally, because Hanford soils are low in organic matter content and well oxygenated, it is unlikely that the hexavalent state of chromium will be altered or

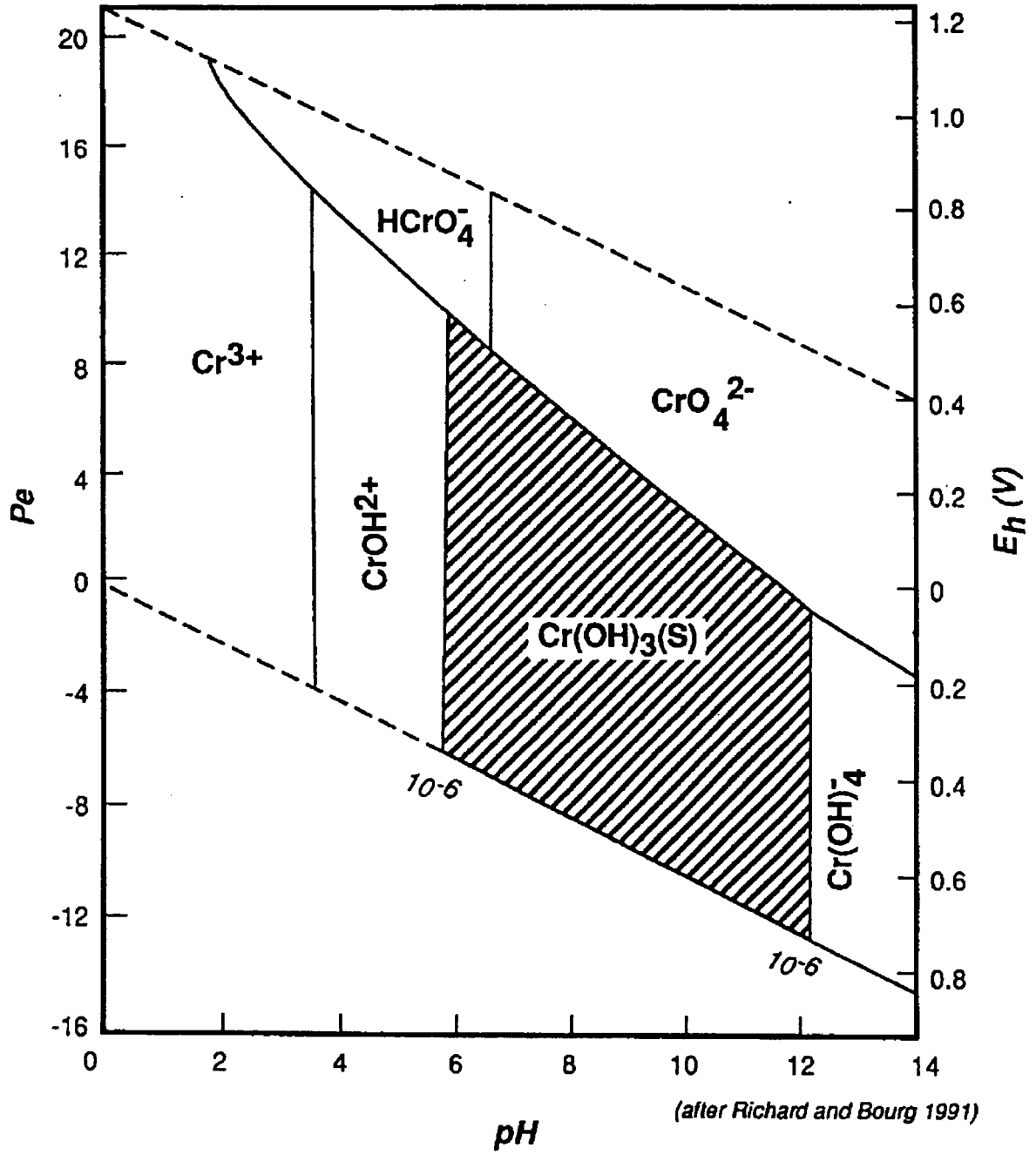


Figure B-7. Expected Chromium Species Versus pH and Redox Potential (Eh) (Hanford soil and groundwater pH is about 8 and Eh should be > 0.5 V under the expected well oxygenated conditions).

reduced to the immobile Cr(III) state (Thornton, 1995). The high percentage of chromium in tank sludge samples that is readily solubilized with either water or base supports the expectation that hexavalent chromium in the first cycle waste stream, and transfered to SSTs, was soluble and capable of subsequent movement through the soil column from a leak. It is thus important as a 'marker' of tank related waste sources, especially when this occurs in combination with other expected constituents.

Strontium-90 in water wash fractions of tank wast occurs at concentrations about 1/10 to 1/100 th of the cesium-137 concentration even though these two fission products are produced in about equal amounts (on a Curie or activity basis). Apparently a major portion of the strontium-90 precipitated in the tanks. It is assumed that the soluble constituents represented by the water wash fraction of tank sludge samples would have been initially available to migrate through the soil column from a tank leak. The ultimate vertical distribution in the soil column would depend on the affinity of the individual constituents for the soil matrix through which the aqueous waste migrated. For example, as indicated in Figure B-4, cesium-137 would be expected to travel more slowly than strontium-90, which should migrate more slowly than the highly mobile constituents. The high salt, high pH waste however could have modified this expectation as suggested in the following discussion.

Because of the high temperature and high pH of the first cycle waste, it is possible that some dissolution of silica or glass inclusions (mesostasis) in basaltic sand components of the soil column that initially contained the leak volume could have occurred. The dissolution process could have increased the permeability of the soil and reduced sorption of cesium-137 and strontium-90. However, such reactions also can result in production of a gelatinous precipitate. Formation of the gel presumably would impede moisture migration. This type of waste-form, soil matrix effect is indicated in Figure B-3 and B-4 as the initial soil volume occupied by the hypothetical leak (stippled areas immediately beneath and adjacent to the tank and beneath diversion box). Additional work is needed to determine if the hypothesized dissolution based on laboratory observations of basalt in high pH media (F. N. Hodges, pers. comm.) actually occurs in sediments beneath the S-SX Tank Farm. Soil column leaching experiments may be needed to confirm or reject the hypothesized waste matrix-soil reaction and its affect on sorption properties.

The timing of the leaks also may be important because leaks that occurred early in the life of a tank would be less subject to additional chemical changes due to tank transfers and would have been at much higher temperatures (dissolution increases with temperature). In this regard, the SX-109 through SX-115 were of similar design and all are thought to have failed or leaked soon after placed into service in the late 1950's to mid 1960's.

3.3 OCCURRENCE OF PREDICTED MOBILE TANK WASTE CONSTITUENTS IN GROUNDWATER

If the conceptual model of waste migration through the soil column to groundwater is correct, the hypothesized mobile tank waste constituents should be present in groundwater beneath the tanks or downgradient from the tank

farm. Based on the water wash fraction of sludge samples from the S-SX Tank Farm, the most abundant mobile components expected to appear in groundwater include sodium (or associated ion-exchange products, Ca and Mg), nitrate, technetium-99, tritium, and chromate. Figure B-8 shows the recent concentration history of these constituents in the nearest downgradient RCRA monitoring well located near suspected tank leak sources in the SX Tank Farm. As suggested by Figure B-8, the major expected mobile constituents are present and appear to vary with time in approximately the same manner. However, some deviation from the pattern is evident, especially for tritium (Figure B-8c). In the case of sodium, the ion-exchange reaction noted above could account for the apparent absence or low amounts of excess sodium (refer to discusion of expected and observed sodium levels in Appendix E). The apparent covariance of calcium and magnesium with the other co-contaminants tends to support this explanation (i.e., calcium and magnesium are indicators of the sodium that would have been present in the original tank waste). A more complete or quantitative comparison of calcium and magnesium with the other expected mobile contaminants requires some additional manipulations discussed as follows.

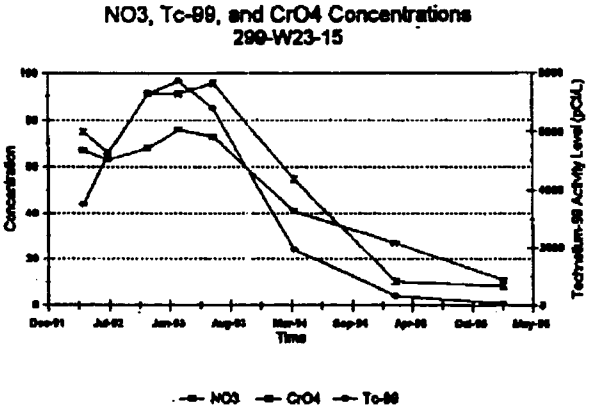
3.3.1 Excess Calcium and Magnesium

Because there is naturally occurring calcium and magnesium in groundwater, the increase in concentration of these divalent cations is somewhat obscured. In addition, to make a direct comparison with the major anionic components (nitrate) theoretically added to groundwater from tank farm waste sources, the units must be in milliequivalents per liter (meq/L). If these are the major ionic constituents there should be equal amounts (meq/L basis) of cations and anions. That is, to satisfy the electroneutrality requirement, there must be equal amounts (meq/L) of positive (cations) and negative (anions) charge.

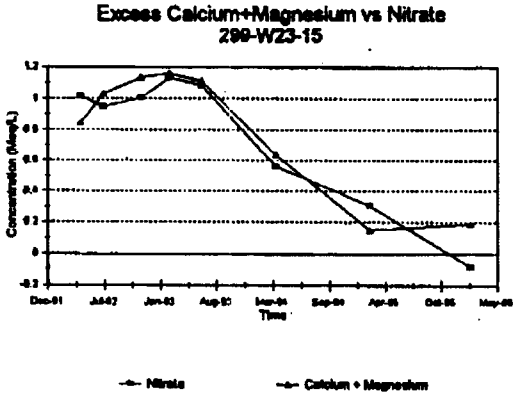
Figure B-8b shows a comparison of the net concentration (downgradient minus upgradient) of calcium plus magnesium versus nitrate. The shape of the excess cation plot and the nitrate are nearly identical, which in turn is very similar to the other mobile contaminants expected in tank waste. This correspondence adds credence to the sodium exchange hypothesis and explains the absence of excess sodium in those samples that apparently have other mobile tank waste constituents (technetium, chromate, nitrate, etc.).

Further support for the sodium-exchange hypothesis is provided by the T-106 soil data. The soil column chemical analysis results for a borehole drilled near the T-106 tank leak in the T Tank Farm shows that sodium is separated from nitrate as would be expected for a high sodium salt liquid migrating through a soil column rich in divalent cations (calcium and magnesium on soil particle ion-exchange sites).

a



b



c

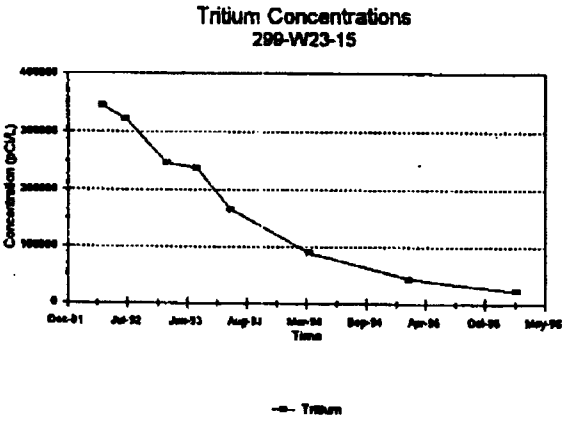


Figure B-8. Comparison of Contaminant Concentrations Versus Time in Downgradient Well 2-W23-15 at the SX Tank Farm.

3.3.2 Enhanced Strontium-90 Mobility Hypothesis

It has been hypothesized that if the divalent calcium ion is mobilized as a result of the sodium exchange mechanism, strontium-90, which is chemically similar to calcium, also might be mobilized and migrate to a greater extent than expected based on low salt conditions. For example, Serne and Legore (1996) demonstrated that the sorption of strontium-90 by Hanford sediments was greatly reduced with increasing calcium or magnesium concentrations. If the enhanced mobility hypothesis is correct (i.e., that strontium-90 travels with the calcium displaced by sodium), then strontium-90 should be detectable in groundwater at those locations where anomalous or excess calcium occurs. However, strontium-90 results for groundwater samples collected from RCRA-compliant monitoring wells for the S-SX WMA have all been non-detects i.e., < the limit of detection of about 0.2 pCi/L. Because the strontium-90 activity (μC/L) is 10 to 100 times higher than technetium-99 in water wash fractions of SX tank sludge samples, and technetium-99 concentrations of up to 8,000 pCi/L coincide with the excess calcium in groundwater, it should have been easily detectable in groundwater. Perhaps, strontium-90 is selectively incorporated into calcic mineral phases that offset the Na-Ca exchange displacement effect. Or, perhaps more complex ion-exchange dynamics occur as the initially high sodium waste migrates downward through the soil column; e.g., 'chromatographic' separation where the calcium and magnesium displaced by the sodium migrate ahead of the strontium. Nevertheless, the hypothetical possibility of enhanced transport of strontium-90 due to the sodium ion-exchange mechanism requires additional evaluation.

It also should be noted that at the initial or starting point where interstitial fluid composition is dominated by the tank waste, sorption of all constituents could be greatly reduced due to dissolution effects of the high pH media and or due to competitive ion exchange resulting from the multimolar sodium concentrations. As meteoric water and or artificial sources dilute the original tank waste in the soil, sorption conditions should grade back to low salt conditions. Thus, there is very likley a range of mobility (Kds) for strontium-90.

3.3.3 Apparent Tritium Discrepancy

As noted previously, tritium should be present in any tank leak and should hypothetically co-vary with the other mobile constituents. However, this constituent deviates from this expectation. Figure 8c shows that tritium does not appear to be in phase with the other expected co-contaminants in downgradient well 2-W23-15. However, because since large amounts of tritium were disposed to cribs upgradient from this well, the residual tritium from cribs may have 'masked' the expected tritium associated with the other mobile co-contaminants from tank waste.

Although not all of the mobile tank farm contaminants in groundwater beneath the S-SX WMA are co-variant (e.g., tritium), the apparent covariance of the other expected co-contaminants warrants further investigation and is sufficient for a 'more-probable-than-not' determination.

4.0 REFERENCES

Serne, R. J. and V. L. Legore, 1996, *^{90}Sr Adsorption-Desorption Properties and Sediment Characterization at 100 N Area*, PNL-10899, Pacific Northwest Laboratory, Richland, Washington.

Thornton, E. C., 1995, J. E. Amonette, J.A. Olivier, and D. L. Huang, *Speciation and Transport Characteristics of Chromium in the 100 D/H Areas of the Hanford Site*, WHC-SD-EN-TI-302, Rev 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

BACKGROUND INFORMATION FOR CONCEPTUAL MODEL DEVELOPMENT AT SST WMA S-SX

CONTENTS

FIGURE

TABLES

APPENDIX C

BACKGROUND INFORMATION FOR CONCEPTUAL MODEL DEVELOPMENT AT SST WMA S-SX

1.0 REVIEW OF SOURCE FACILITIES/PROCESSES

The SSTs in WMA S-SX are RCRA treatment and storage units that are storing hazardous and radioactive waste remaining from the chemical processing of spent fuel rods to recover and refine weapons grade plutonium and uranium. No waste has been added to these tanks since November 1980, and many ceased receiving waste earlier than 1980 because of failed integrity (refer to Table H-1 in Hanlon 1996). All the SSTs will be closed as RCRA TSD units under WAC 173-303-610. A closure work plan for the SSTs was submitted to Ecology in 1989 (DOE 1989); revision 1 of this plan was submitted to Ecology in May 1996 (DOE/RL 1996). The WMA S-SX is coincident with CERCLA 200-RO-4 operable unit. Anderson (1990) documents the history of tank farm operations. Chemical and radioactive waste inventories of SSTs are documented (WHC 1993).

High-level waste streams from the processing of spent fuel rods in the REDOX Facility (202-S Building) were discharged to various tanks in WMA S-SX. The waste was discharged to the SSTs as alkaline slurries, with pH increased to above 9 by the addition of NaOH before releasing the waste to tanks. Many of the tanks in the 241-SX Tank Farm were self-boiling tanks, with condensate that was collected by condensers atop each tank sent to the 216-S-3 french drain, 216-S-21 crib (or other cribs) surrounding the tank farm. The condensate contained significant quantities of tritium. The combination of phosphate in the tanks as well as the high pH led to the precipitation of much of the uranium in the waste tanks as sludge, with only a small soluble fraction of uranium remaining in the supernate. Waste that leaked from the tanks to surrounding soils was mostly supernatant that would have been depleted in uranium because of precipitation indicated previously. The fractionation of the high-level waste stream during chemical processing might account for the differences in contaminant populations that are apparent in groundwater beneath SST WMA S-SX and the surrounding cribs/french drains.

All the SSTs in WMA S-SX are constructed of reinforced concrete with a single liner of ASTM A283 Grade C carbon steel. The 100 series of tanks are all 75 ft. in diameter and are buried from 6 - 8 ft below ground surface. The cylindrical tank beneath the domed top of each tank extends to varying depths depending on the capacity of the tanks and their position in a cascade sequence. The 12 SSTs in the 241-S Tank Farm are all 100-series tanks, each of which held 750,000 gallons and were constructed in 1951-52. The only "Assumed Leaker" in the 241-S Tank Farm is the 241-S-104 tank, which was declared an assumed leaker in 1968. The 15 SSTs in the 241-SX Tank Farm are all 100-series tanks, each of which held 1,000,000 gallons and were constructed during 1953 and 1954. Ten of the 15 tanks in the 241-SX Tank Farm are assumed leakers, with the earliest declaration of leaker status in 1968 for the SX-108 tank. All nine self-boiling tanks in the 241-SX Tank Farm are assumed leakers (Figure C-1). Unlike the 241-S Tank Farm in which all tanks were constructed with curving dished bottoms, tanks in the 241-SX Tank Farm

were constructed with an orthogonal intersection of liner sidewall and bottom and this intersection was a frequent locus of failure because of the stresses generated by self-boiling waste.

All of the tanks in both the 241-S and 241-SX Tank Farms were constructed such that waste could flow laterally (i.e., cascade) through connecting pipes from one tank into another once waste exceeded the level of the cascade line in a tank. Waste would be placed initially in the first tank and allowed to cascade to the other two tanks in a cascade line. There were four rows of cascading tanks (three in each line) in the 241-S Tank Farm and five rows of cascading tanks in the 241-SX Tank Farm. Cascade lines connecting groups of three tanks were plugged on several occasions and also were not sealed adequately at the junction with tanks, thereby leading to escape of waste from containment. Waste went from processing plants through settling tanks and diversion boxes to the SSTs and was directed to various tanks by valves allowing flow of waste along transfer lines coming out of diversion boxes. There were three separate transfer line systems in the 241-SX Tank Farm: one emanating from the 241-SX-151 Diversion Box, another from the 241-SX-152 Diversion Box, and a third from the 242-S Evaporator. None of the transfer lines were double contained and leaks were known to have occurred along each line. As with cascade lines, the junction of lines with the tank either was not properly sealed or developed leaks during operations, for these intersections were routes of egress of waste from tanks to the soil.

2.0 MONITORING THE INTEGRITY OF THE SINGLE-SHELL TANKS

The SSTs were monitored to detect leaks using in-tank measurements of liquid levels and gross gamma surveillance logging in external boreholes (Welty 1988). A drop of liquid levels between successive readings of liquid levels in a tank would signify possible loss of fluids that, if not explained by other phenomena, suggested a loss of integrity of the tank. Most tanks in the 241-SX Tank Farm were self-boiling tanks making the measurement of liquid levels difficult and impossible to distinguish between liquids lost through evaporation and leaks. In these tanks, liquid observation wells (LOW) were installed and gross gamma logging was used to detect fluid losses. Gross gamma logging in radially disposed boreholes adjacent to the tanks (Figure B-1) was used to confirm the loss of liquid from a tank and/or to monitor the movement of fluids once escaped from a tank. However, this technique was a primary leak detection method in the self-boiling tanks in the SX Tank Farm. Lateral lines also were present beneath the nine self-boiling tanks in the SX Tank Farm (Figure C-1) and these also were logged with the gross gamma surveillance tool to check on possible loss of fluids. Three lateral lines radiating from a caisson located amid four tanks were located a few feet beneath each tank. The gross gamma surveillance logs were used to qualitatively assess new leaks by comparison with previous readings.

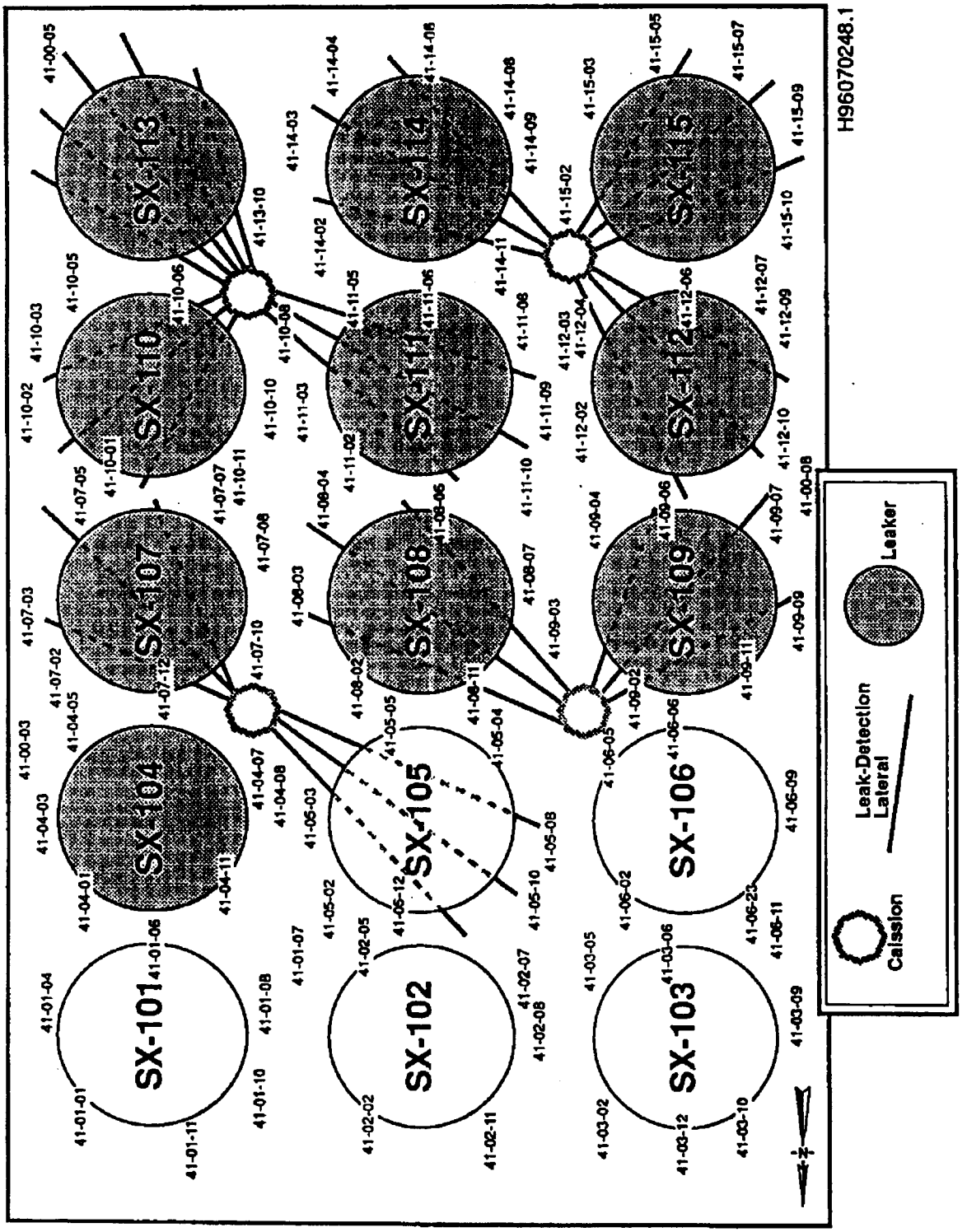


Figure C-1. Plan Map of the S-SX Tank Farm Showing Boreholes and Laterals.

Any sudden change in the amplitude or depth of an above-background peak was cause for suspicion about failed integrity and would trigger further study. Once declared as leaking, waste would be pumped from the subject tank to other sound SSTs or DSTs and the tank would await interim stabilization.

2.1 CURRENT VADOSE ZONE MONITORING PROGRAM

Spectral gamma logging is now conducted in boreholes surrounding the SSTs. Spectral gamma logging can be used to identify and quantify the specific gamma-emitting isotope present at a given elevation in a borehole. Spectral gamma logging in SST tank farms is being conducted by RUST Geotech contracted directly to DOE. In logging these boreholes, 100 second counts are taken in each borehole at increments of 0.5 foot. Baseline logging has been completed in the 241-SX Tank Farm (refer to appended list of references for tank data reports for 241-SX Tank Farm) and results are summarized on Table C-1. The ^{137}Cs is essentially the only anthropogenic isotope that has been identified in boreholes in the SX Tank Farm and has been found as deep as 125 feet. Radioactive contamination previously detected in borehole 41-12-02 by gross gamma surveillance logging at this depth has now been identified as ^{137}Cs at >10,000 pCi/g with spectral gamma logging. The identification of ^{137}Cs in this and at the bottom of other monitoring boreholes has triggered a separate investigation of the vadose zone to determine the mechanisms of transport to this depth. In particular, the investigations are focusing on whether there are unique geochemical circumstances/processes that lead to greater interstitial infiltration, or whether preferential pathways (natural or artificial, including the indiscriminate addition of liquids to the soil) may be responsible for greater penetration of ^{137}Cs than previously found or anticipated.

2.2 WASTE MIGRATION IN THE SOIL

Once waste had escaped containment, natural and artificial recharge enhances mobility and leads to deeper infiltration of the waste. The proportion of natural recharge that infiltrates beneath the top few feet is not known with any precision. Where coarse cover materials have been placed and vegetative growth is prevented (as has been true for tank farms), natural precipitation (mean annual is 6.25 in/yr) may infiltrate deeper than in areas covered with finer soils and vegetation. By severely restricting evapotranspiration through emplacement of gravel and restricting vegetation, recharge from natural precipitation is enhanced. Natural recharge can be further enhanced through other preferential pathways that channel infiltration deeper into the vadose zone. For example, unsealed boreholes and clastic dikes that are common in the 241-S and 241-SX Tank Farms may have assisted the further infiltration of natural and artificial recharge. Sudden melting of snowcover following prolonged periods of sub-freezing weather have occurred during several winters since the 1950s when these tanks were constructed. Chinook winds that rapidly melt snow produce meltwater that can not infiltrate into frozen substrate leads to ponding of water in tank farms that can preferentially infiltrate along unsealed boreholes and/or clastic dikes. Water also has been indiscriminately added to the soils through

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
SX-101	41-01-01	W23-132	3/21/72	6	140	NA	140	No	?	Yes (0 - 20'; <100 pCi/g)	Broad peak <2 pCi/g @ 40-46';<1 pCi/g @ 52 - 56', <2 pCi/g @ 62'	N
	41-01-04	W23-190	11/1/74	6	100	NA	100	No	?	Yes (0 - 18'; <11 pCi/g)	Continuous <1 pCi/g 18 - 39'; 4pCi/g @100'	N
	41-01-06	W23-133	12/27/71	6	100	NA	100	No	?	Yes (0 - 57'; <1,000 pCi/g)	Peaks: 200 pCi/g @ 16'; <300 pCi/g @ 31'; <5 p'Ci/g @ 51' 1pCi/g @ 96'	N
	41-01-07	W23-60	9/21/54	8	101	NA	101	Yes	?	Yes (0 - 9'; <17 pCi/g)	Detected 0 - 94; peaks <2pCi/g @ 47 - 49'; 62'	N
	41-01-08+	W23-134	1/3/72	6	100	NA	100	No	?	Yes (0 - 32'; <11 pCi/g)	Spotty entire borehole <3 pCi/g	N
	41-01-10+	W23-191	11/20/74	6	100	NA	100	No	?	Yes (0 - 27'; <60 pCi/g)	1-6pCi/g @ 51-67'; 5 pCi/g @ 100'	N
	41-01-11	W23-192	11/18/74	6	100	NA	100	No	?	Yes (0 - 20'; <11 pCi/g)	<1 pCi/g @ 46 - 56'	N
SX-102	41-02-02+	W23-135	1/14/72	6	140	NA	140	No	?	Yes (0 - 65"; <50 pCi/g)	12 pCi/g @ 33-36'; 10pCi/g @ 68'; ??pCi/g @ 70'; 6pCi/g @ 140	N
	41-02-05	W23-223	7/31/78	6	130	NA	130	No	?	Yes (0 - 38'; <500 pCi/g)	3pCi/g @ 65'; 4pCi/g @ 110'	N
	41-02-07	W23-59	9/30/54	8	101	NA	101	Yes	?	Yes (0 - 8'; <100 pCi/g)	1-3pCi/g @ 35-65'; 3-4pCi/g @ 71'	N
	41-02-08+	W23-136	1/18/72	6	100	NA	100	No	?	Yes (0 - 18'; <50 pCi/g)	5pCi/g @ 50'; 2pCi/g @ 98'	N
	41-02-11	W23-193	10/28/74	6	100	NA	100	No	?	Yes (0 - 30'; <500 pCi/g)	7pCi/g @ 50-55'	N
SX-103	41-03-02	W23-194	10/30/74	6	100	NA	100	No	?	Yes (0 - 60'; <300 pCi/g)	1 - 12pCi/g @ 4-60'; peaks at33 ',40' & 58'(12 pCi/g); 3 pCi/g @ 48'	N
	41-03-05	W23-195	11/25/74	6	100	NA	100	No	?	Yes (0 - 19'; <12 pCi/g)	<1 - 8pCi/g @ 20 - 61'; 10pCi/g @ 100'	N

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-03-06	W23-138	2/17/72	6	100	NA	100	No	?	Yes (0 - 7'; <11 pCi/g)	<1 pCi/g @ 9 - 17'; essentially clean below	N
	41-03-09	W23-139	2/11/72	6	100	NA	100	No	?	Yes (0 - 27'; <13 pCi/g)	Spotty contamination <1 pCi/g 29 - 98'	N
	41-03-10	W23-196	10/25/74	6	100	NA	100	No	?	Yes (0 - 14'; <70 pCi/g)	<2 pCi/g @ 16 - 25'; <1pCi/g @ 68'	N
	41-03-12+	W23-137	2/24/72	6	100	1973	140	No	?	Yes (0 - 22'; <70 pCi/g)	<1 pCi/g @ 27 - 36'; < 4 pCi/g @ 137 - 138''	N
SX-104**	41-04-01	W23-140	3/15/72	6	100	NA	100	No	?	Yes (0 - 21'; <10 pCi/g)	1 pCi/g @ 49' & 80'; spotty contamination <1 pCi/g 23 - 98'	N
	41-04-03	W23-197	11/12/74	6	100	NA	100	No	?	Yes (0 - 22'; <5 pCi/g)	5 pCi/g @ 20'	N
	41-04-05	W23-198	11/14/74	6	100	NA	100	No	?	Yes (0 - 17'; <80 pCi/g)	Spotty contamination 17 - 90'; <2 pCi/g @ 100'	N
	41-04-07+	W23-62	9/30/54	8	101	NA	101	Yes	?	Yes (0 - 2'; <9 pCi/g)	1pCi/g @ 53'; 7pCi/g @ 100'; contamination continuous in hole	N
	41-04-08	W23-225	4/4/78	6	125	NA	125	No	?	Yes (0 - 6'; <6 pCi/g)	Few spotty detections 6 - 100' <0.5 pCi/g	N
	41-04-11	W23-141	3/9/72	6	100	NA	100	No	?	Yes (0 - 21'; <40 pCi/g)	1 pCi/g @ 27'; <0.9 pCi/g @ 101'; Eu-154 < 4 pCi/g @ 4'	N
SX-105	41-05-02	W23-130	?	6	130	NA	130	No	?	Yes (0 - 24'; <11 pCi/g)	Broad peak >1pCi/g @ 45 - 62'; 2-3 pCi/g @ 124'	N
	41-05-03	W23-131	?	6	125	NA	125	No	?	Yes (0 - 38'; <12 pCi/g)	1 pCi/g @ 57'	N
	41-05-05	W23-125	5/31/70	6	100	1973	135	No	?	Yes (0 - 20'; <7 pCi/g)	1 pCi/g @ 123-132'	N
	41-05-07	W23-126	1970?	6	75	1973	135	No	?	Yes (0 - 40'; <12 pCi/g)	4 pCi/g @ 75'; <1 pCi/g @ 120-122'	N

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-05-08	W23-127	1970?	6	75	1973	135	No	?	Yes (0 - 20'; <110 pCi/g)	<1 pCi/g @ 42-47'	N
	41-05-10	W23-128	1970?	6	75	1973	135	No	?	Yes (0 - 19'; <11 pCi/g)	<1pCi/g @ 30-35'; 3 pCi/g @ 90'	N
	41-05-12	W23-129	?	6		1978	130	No	?	Yes (0 - 25'; < 14 pCi/g)	<4 pCi/g @ 37'; <1 pCi/g @ 124'	N
SX-106	41-06-02	W23-142	3/2/72	6	100	NA	100	No	?	Yes (0 - 38'; <13 pCi/g)	1+ pCi/g @ 62'; 1+pCi/g @ 100'	N
	41-06-05	W23-143	3/21/72	6	100	1973	140	No	?	Yes (0 - 10'; <13 pCi/g)	<1 pCi/g @ 30-43'	N
	41-06-06++	W23-226	4/17/78	6	130	NA	130	No	?	Yes (0 - 10'; <8 pCi/g)	<1 pCi/g @ 122'; 1 pCi/g @ 16'	N
	41-06-09	W23-144	3/24/72	6	100	NA	100	No	?	Yes (0 - 28'; <3 pCi/g)	<1 pCi/g @ 69'	N
	41-06-11	W23-58	9/13/54	8	101	NA	101	Yes	?	Yes (0 - 10'; <1 pCi/g)	<1 pCi/g @ 66'	N
	41-06-23	W23-227	5/2/78	6	130	NA	130	No	Yes	Yes (0 - 8'; < 3 pCi/g)	No detections > 12 '	N
SX-107**	41-07-02	W23-74	2/19/62	6	75	NA	75	No	?	Yes (0 - 24'; <6 pCi/g)	<1 pCi/g @75-76'	N
	41-07-03	W23-75	2/20/62	6	75	NA	75	No	?	Yes (0 - 16'; <4 pCi/g)	1 pCi/g @15'; <1 pCi/g @ 75'	N
	41-07-05	W23-76	2/28/62	6	75	NA	75	No	?	Yes (0 - 12'; <6 pCi/g)	>1,000 pCi/g @ 50-60'; 3 pCi/g @ 75'	Y (54 - 59')
	41-07-07	W23-77	2/21/62	6	75	NA	75	No	?	Yes (0 to peak @ 54')	>1,000 pCi/g @ 54 -76'; 2-3 pCi/g @ 25', 32', & 41'	Y (54 - 66')
	41-07-08	W23-78	2/22/62	6	75	NA	75	No	?	Yes (0 - 10'; <11 pCi/g)	<1000 pCi/g @ 59'; 1+ pCi/g @ 75'	N
	41-07-10	W23-79	2/23/62	6	75	NA	75	No	?	Yes (0 - 12'; <6 pCi/g)	<1 pCi/g @ 40'	N
	41-07-12	W23-73	2/16/62	6	75	1973	90	No	?	Yes (0 - 20'; <11 pCi/g)	<2 pCi/g @54'; <9pCi/g @ 62'	N
SX-108**	41-08-02	W23-102	3/16/62	8	75	NA	75	No	?	Yes (0 to peak @ 52')	>1 pCi/g entire borehole; >1,000 pCi/g @ 54-57	N
	41-08-03	W23-103	3/19/62	6	75	NA	75	No	?	Yes (0 - 75')	<1 pCi/g entire borehole; 1 pCi/g @ 40'; 3 pCi/g @ 66'	N

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-08-04	W23-98	3/14/62	6	75	NA	75	No	?	Yes 0 - 70')	Cs-137 throughout entire borehole; 3 pCi/g @ 21'; 3, 8 pCi/g @ 45, 50'; 1 pCi/g @ 76'	N
	41-08-06	W23-99	3/12/62	6	135	NA	135	No	?	Yes (0 - 7'; <2 pCi/g)		N
	41-08-07	W23-100	3/16/62	6	75	NA	75	No	?	Yes (0 - 61' peak; <300 pCi/g)	Cs-137 throughout hole 1 - 300 pCi/g; >1,000 pCi/g 65 - 75'	Y (62 - 75')
	41-08-11	W23-101	3/15/62	6	75	NA	75	No	?	Yes (0 to peak @ 46'; <15 pCi/g)	<1 - 10 pCi/g 0 - 49'; >100 pCi/g 46 - 62'; 5 - 10 pCi/g 62 - 75'	Y (48 - 62')
SX-109**	41-09-02	W23-110	3/23/62	6	75	NA	75	No	?	Yes (0 - 10'; <3 pCi/g)	Cs-137 throughout entire hole < 1pCi/g; <0.9 pCi/g Eu-154 @ 6'	N
	41-09-03	W23-104	3/19/62	6	75	NA	75	No	?	Yes (0 - 58'; <13 pCi/g)	Cs-137 throughout entire hole <3 pCi/g; > 1,000 pCi/g @ 58-72'; >12 pCi/g 72-75'	Y (59 - 72')
	41-09-04#	W23-105	3/21/62	6	75	1972	105	No	?	Yes (0 - 57'; <4,000 pCi/g)	10 - 4,000 pCi/g 0 - 57'; not logged >57' because of internal borehole contamination	Y (57 - ?)
	41-09-06	W23-106	3/20/62	6	75	NA	75	No	?	Yes (0 - 8'; <11 pCi/g)	0.2 pCi/g @ 75'; no activity >12'	N
	41-09-07	W23-107	3/22/62	6	75	NA	75	No	?	Yes (0 - 63'; <80 pCi/g)	Cs-137 in entire borehole < 2 pCi/g; >100 pCi/g @ 60-62'	Y (63 - 75')
	41-09-09	W23-108	3/22/62	6	75	1972	130	No	?	Yes (0 - 5'; <7 pCi/g)	<100 pCi/g @65; > 1,000 pCi/g 71 - 75'	Y (71 - 74')
	41-09-11	W23-109	3/23/62	6	75	NA	75	No	?	Yes (0 - 4'; <9 pCi/g)	Detectable Cs-137 30 - 75' <0.7 pCi/g	N
SX-110**	41-10-01	W23-80	2/22/62	6	75	1973	135	No	?	Yes (0 - 5'; <7 pCi/g)	<6 pCi/g @ 65 - 66'	N

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-10-02	W23-66	3/1/56	8	126	NA	126	No	?	Yes (0 - 2'; <9 pCi/g)	< 1pCi/g @ 123'	N
	41-10-03	W23-81	2/26/62	8	75	NA	75	No	?	Yes (0 - 75'; <4 pCi/g)	Cs-137 detectable <1 pCi/g entire hole; 9 pCi/g @ 75'; <2 pCi/g @ 14'	N
	41-10-05	W23-82	2/26/62	6	75	NA	75	No	?	Yes (0 - 12'; <5 pCi/g)	<1 pCi/g @ 75'	N
	41-10-06	W23-83	2/27/62	6	75	NA	75	No	?	Yes (0 - 20'; <10 pCi/g))	Spotty <0.3 pCi/g @ 75'	N
	41-10-08	W23-84	2/27/62	6	75	NA	75	No	?	Yes (0 - 6'; <9 pCi/g)	Spotty contamination <1 pCi/g	N
	41-10-10	W23-67	3/16/56	8	126	NA	126	No	?	Yes (0 - 2'; <11 pCi/g)	<4 pCi/g 124 - 125'	N
	41-10-11	W23-85	3/1/62	6	75	NA	75	No	?	Yes (0 8'; <1 pCi/g)	<2 pCi/g @ 57 - 75'	N
SX-111**	41-11-02	W23-96	3/14/62	6	75	NA	75	No	?	Yes (0 - 4'; < 13 pCi/g)	Few scattered detections > 5 '	N
	41-11-03	W23-97	3/15/62	6	75	1973	135	No	?	Yes (0 - 21'; <13 pCi/g)	1 pCi/g @ 19'; scattered detections @ 10 - 22'	N
	41-11-05	W23-92	3/8/62	6	75	1973	135	No	?	Yes (0 - 5'; < 13 pCi/g)	Essentially clean	N
	41-11-06	W23-93	3/31/62	6	75	NA	75	No	?	Yes (0 - 20'; <9 pCi/g)	<12 pCi/g @ 60-75'	N
	41-11-08	W23-94	3/9/62	8	75	1973	135	No	?	Yes (0 - 5'; <10 pCi/g)	Few scattered detections @ 14 - 19'	N
	41-11-09	W23-95	3/12/62	6	75	NA	75	No	?	Yes (0 - 8'; <11 pCi/g)	<2 pCi/g @ 62 - 75'	N
	41-11-10	W23-64	3/7/56	8	125	NA	125	No	?	Yes (0 - 2'; <60 pCi/g)	<300 pCi/g @ 61 - 65'; >1,000 pCi/g @ 65-71; <800 pCi/g @79 & 82; <2 pCi/g @ 125'	Y (65 - 71; 82 - 84')
SX-112**	41-12-02#	W23-111	3/26/62	6	75	1972##	125	No	No	Yes (0 - 75')	>10,000 pCi/g 68 - 105' & 112-125'	Y (67 - 106; 114 - 125')
	41-12-03	W23-112	3/26/62	6	75	NA	75	No	?	Yes (0 - 14'; <11 pCi/g)	10 - >10,000 pCi/g @ 60 - 70'	Y (64 - 67')

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Manf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-12-04	W23-68	3/31/56	8	125	NA	125	??	?	Yes (0 - 1'; <2 pCi/g)		N
	41-12-06	W23-113	3/27/62	6	75	NA	75	No	?	Yes (0 - 75'; <4 pCi/g 0 - 18')	<1 pCi/g @ 15-72'	N
	41-12-07	W23-114	4/4/62	6	75	NA	75	No	?	Yes (0 - 16'; <3 pCi/g)	Scattered detections <0.5 pCi/g entire borehole	N
	41-12-09	W23-115	3/27/62	6	75	NA	75	No	?	Yes (0 - 16'; <11 pCi/g)	<3 pCi/g @ 18 - 24'	N
	41-12-10	W23-116	3/29/62	6	75	NA	75	No	?	Yes (0 - 6'; <2 pCi/g)	Essentially clean	N
SX-113**	41-13-10	W23-72	10/6/58	6	100	NA	100	No	?	Yes (0 - 2'; <12 pCi/g)	Essentially clean	N
SX-114**	41-14-02	W23-91	3/9/62	6	75	NA	75	No	?	Yes (0 - 75')	<1 pCi/g throughout hole; <4 pCi/g @ 76.7'	N
	41-14-03	W23-86	3/1/62	6	75	NA	75	No	?	Yes (0 - 5' ; <2 pCi/g)	<1 pCi/g @ 58 - 74', <5 pCi/g @ 75'	N
	41-14-04	W23-69	3/20/56	8	125	NA	125	No	?	Yes (0 - 6'; <6 pCi/g)	<.0.6 pCi/g at 125'	N
	41-14-06	W23-87	3/2/62	6	75	NA	75	No	?	Yes (0 - 75'; <1 pCi/g)	<1 pCi/g throughout hole; <1 pCi/g Co-60 @ 35' & 65 - 75'	N
	41-14-08	W23-88	3/3/62	6	75	NA	75	No	?	Yes (to ~ 8'; <1 pCi/g)	Essentially clean	N
	41-14-09	W23-89	3/6/62	6	75	NA	75	No	?	Yes (0 - 16'; <2 pCi/g)	<1 pCi/g @ 63'; <2 pCi/g @ 75'	N
	41-14-11+	W23-90	3/6/62	6	75	NA	75	No	?	Yes (0 - 10'; <5 pCi/g)	Spotty--<1 pCi/g @ 15-46'; <1 pCi/g @ 70 - 75'	N
SX-115**	41-15-02	W23-117	3/29/62	6	75	NA	75	No	?	Yes (0 - 5'; <2 pCi/g)	Essentially clean	N
	41-15-03	W23-118	4/2/62	6	75	NA	75	No	?	Yes (0 - 4'; <5 pCi/g)	<2pCi/g @ 75'	N
	41-15-05	W23-119	3/20/62	6	75	NA	75	No	?	Yes (0 - 7'; <5 pCi/g)	Essentially clean	N
	41-15-07	W23-70	3/27/56	8	125	NA	125	No	?	Yes? - ground surface only <1 pCi/g)	<7 pCi/g @ 57'; <1 pCi/g @ 55-60	N

Table C-1. Summary Table of Spectral Gamma Logging in Boreholes in the 241-SA Tank Farm.

Tank No.	Tk. Fm. No.	Hanf. No.*	Constructed	Diam. (in)	Depth (ft)	Date Deep.	TD	Casing Perf.	Cem. Plug	Surface Contamination	Cs-137 Cont.	Detector Sat.
	41-15-09	W23-120	4/3/62	6	75	NA	75	No	?	Yes (0 - 3'; <8 pCi/g)	Spotty <1 pCi/g	N
	41-15-10	W23-121	4/30/62	6	75	1973	125	No	?	Yes (0 - 23'; <11 pCi/g)	<2pCi/g @ 125'	N
SX Farm***	41-00-02	W23-61	9/23/54	8	102	NA	102	Yes	?	Yes (0 - 2'; <2 pCi/g)	1 pCi/g @ 33'; <3 pCi/g @ 54 & 56'	N
	41-00-08	W23-65	3/14/56	8	125	NA	125	No	?		<70 pCi/g @ 66 - 69'; <110 pCi/g @76 - 80'	N

NOTES:

* All Hanford well numbers are preceeded by 299-.
** Tank is an Assumed Leaker.
*** Dry wells located around periphery of tank farm and not associated with any one tank.
\+ Borehole is a candidate for deepening.
++ Bottom of borehole grouted in place.
\# Internal contamination present in borehole.
<1,000 mR/h 75' - 80' during deepening of borehole; background radiation > 95' depth.

hydrocompacting of fill in newly excavated trenches and through leaks in raw and sanitary water distribution lines.

Lateral and vertical spreading of artificial recharge (discharge of liquid effluent to surrounding cribs and french drains (refer to Table C-2) also has assisted in mobilizing and transporting waste that has escaped containment. A well documented case of such phenomena occurred east of the 241-SX Tank Farm when effluent discharged to the 216-U-16 crib in 1985 served to mobilize uranium previously discharged to the 216-U-1 and 216-U-2 cribs (Law and Schatz 1986). Uranium eventually was recovered through groundwater pumping and treatment of contaminated groundwater by an ion exchange process. Effluent from this recovery process at the 242-S Evaporator was discharged to the 216-S-25 Crib, which is located hydraulically upgradient of the 216-SX Tank Farm.

Lateral spreading of fluids discharged to soils is enhanced by stratification in the sediments. Not only are there significant differences in unsaturated hydraulic conductivity between various units of the Hanford and Ringold Formations, but also between superposed sedimentation units within each. Thin and discontinuous beds/lenses of mud-rich units are present in the various cyclic sedimentation units in the Hanford formation and these favor lateral spreading. Lateral spreading waste also can encounter other preferential pathways (e.g., unsealed boreholes, wells, clastic dikes) that can enhance vertical infiltration and circumvent natural interstitial infiltration.

3.0 INTERIM STABILIZATION

A program of interim stabilization has been instituted in the SSTs. The objective of interim stabilization is to minimize the risk of further leaks by removing as much liquid from the tanks as possible. Two (of 12) tanks in the 241-S Tank Farm (including S-104, an assumed leaker) have been interim stabilized; nine (of 15) tanks in the 241-SX Tank Farm have been interim stabilized (including most of the assumed leakers).

Table C-2. Liquid Effluent Facilities in the Vicinity of the 241-SX Tank Farm.

Facility No.	Type	Operating Dates	Waste Volume (gals)	Waste Types
216-S-1&2	Cribs	1/52 - 1/56	42,272,100	202-S Cell drainage/condensate
216-S-3	French Drain	9/53 - 8/56	1,109,640	Condensate from 101-S & 104-S tanks
216-S-4	French Drain	8/53 - 8/56	264,201	Condensate/cooling from 101-S & 104-S tanks
216-S-8	Trench	11/51 - 2/52	2,642,010	Nonirradiated startup waste from 202-S
216-S-21	Crib	11/54 - 2/69	23,011,900	241-SX condensate via 206-SX tank
216-S-25	Crib	11/73 - 6/95	76,089,800	242-S Evaporator steam condensate to 1980; SX tank from cooling water thereafter*
216-U-10	Pond	7/44 - 8/85	43,593,100,000	Various waste streams, mostly cooling and process cooling water, steam condensate, laboratory and operations waste
		TOTAL	43,738,500,000	

NOTES:

*Also received effluent from ion exchange process to remove U from 216-U-1, -U-2 cribs.

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APPENDIX D

AS-BUILT DIAGRAMS OF SST WMA S-SX GROUNDWATER MONITORING WELLS

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WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Row/Gentz
Drilling Company: Not documented
Date Started: 01Nov52

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 06Jun56

WELL NUMBER: 299-W22-1
TEMPORARY WELL NO: 241-S-9
Hanford Coordinates: N/S N 35,455 E/W W 75,208
State NAD83 N 134,268.43m E 566,974.82m
Coordinates: N 440,564 E 2,220,026
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): 667.25 Brass cap

Depth to water: 203-ft Jun56
(Ground surface) 200.9-ft 20Dec88

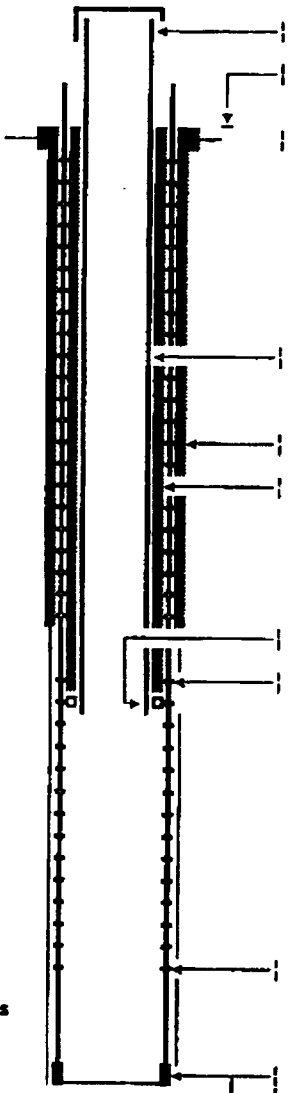
GENERALIZED STRATIGRAPHY — Driller's Log

0-25: BACKFILL
25-34: GRAVEL PACK
34-40: GRAVEL PACK & sandy SILT
40-45: Sandy SILT & GRAVEL
45-48: GRAVEL, SAND & SILT
48-55: SAND
55-60: SAND, GRAVEL & SILT
60-65: SAND with SILT
65-100: Sandy SILT
100-105: SILT
105-130: Sandy SILT - SILT
130-145: Sandy SILT & CLAY
145-150: CLAY & GRAVEL
150-166: GRAVEL, SAND & SILT
166-176: SAND
176-180: SAND & SILT
180-196: GRAVEL
196-206: GRAVEL & SILT
206-210: GRAVEL
210-226: GRAVEL & SILT
226-230: GRAVEL, SAND & SILT
230-234: GRAVEL & SAND
234-238: SAND & SILT
238-244: GRAVEL, SAND & SILT
244-246: GRAVEL & SAND
246-250: SAND
250-254: SAND & GRAVEL
254-262: COBBLES & SAND
262-280: GRAVEL, SAND & SILT
280-290: SAND
290-306: SAND, GRAVEL with SILT
306- : SAND & GRAVEL

Drilled in two stages:
0-150-ft 11-16Jan52
150-306-ft, 21May56-06Jun56

Driller's Note:
Contamination and high temperatures encountered, 150-190-ft.

REMEDIATION: May80 by Bultena
Perforated 0-185-ft and set 6-in casing on packer at 193-ft, then grouted w/127-gals grout.



Elevation of reference point (top of casing): [670.01-ft]
Height of reference point above ground surface: [2.76-ft]
Depth of surface seal: [0-193-ft]
Type of surface seal: Grout between 6 & 8-in (perforated) casing.
I.D. of surface casing (if present): [8-in]
I.D. of riser pipe: [6&8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Packer set at 193-ft
Depth top of orig perforations: [190-ft]
Description of perforations:
0-185-ft, not documented
190-210-ft, 4 holes/ft
210-270-ft, 1 hole/ft
270-280-ft, 2 holes/ft
Depth bottom of perforations: [280-ft]
Depth bottom of casing: [306-ft]
Depth bottom of borehole: [306-ft]

Drawing By: RKL/2#W22-01.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-1

WELL DESIGNATION	:	299-W22-1
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 34,455 W 75,209 [200W-06May91]
LAMBERT COORDINATES	:	N 440,564 E 2,220,025 [HANCONV]
		N 134,268.43m E 566,974.82m [NAD83-06May91]
DATE DRILLED	:	Jun56
DEPTH DRILLED (GS)	:	306-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	203-ft, Jun56; 200.9-ft, Dec88
CASING DIAMETER	:	6-in carbon steel, +2.76~193-ft; 8-in carbon steel, +1.8-ft~306-ft
ELEV TOP CASING	:	670.01-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	667.25 Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	8-in casing, 0~185, 190~280-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 8 and 6-in carbon steel casing. 2-ft pad. No posts, capped, not locked. Identification on brass cap in pad. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	One water level, 20Dec88; PNL Annual, Semiannual; WHC Quarterly water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Row, Row/Roberts
Drilling Company: Not documented
Date Started: 06Dec51

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 24May56

WELL NUMBER: 299-W22-2
TEMPORARY WELL NO: 241-S-10
Hanford Coordinates: N/S N 35,429 E/W W 75,221
State NAD83 N 134,260.46m E 566,9780.93m
Coordinates: N 440,538 E 2,220,013
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 666.90 Brass cap

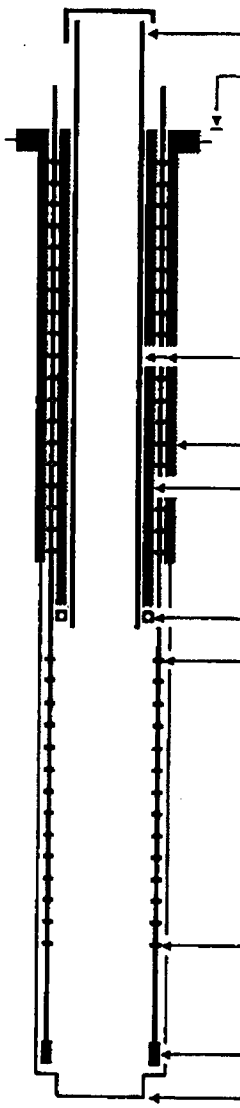
Depth to water: 209-ft May56
(Ground surface) 204.7-ft, Dec91

GENERALIZED STRATIGRAPHY / Driller's Log

0-27: BACKFILL
27-35: GRAVEL PACK
35-40: SAND & SILT
40-47: GRAVEL, SAND, little SILT
47-110: SAND & SILT
110-135: Sandy SILT
135-152: SILT & SAND
152-156: GRAVEL - SAND
156-164: GRAVEL, SAND, some SILT
164-170: SAND, some SILT
170-198: SAND, GRAVEL & SILT
198-208: SAND - GRAVEL
208-224: GRAVEL, SAND, little SILT
224-260: GRAVEL - SAND
260-268: SAND, GRAVEL, little SILT
268-280: SAND, GRAVEL
280-302: SAND
302-307: SAND, GRAVEL, some SILT
Drilled in two stages:
0-150-ft, 06Dec51-03Jan52
150-307-ft, 07May56-24May56

Driller's note:
High temperatures encountered, 150-275-ft. High contamination at 264-266-ft.

REMEDIATION: May80 by Bultena
Perforated 0-188-ft and set 6-in casing on packer at 193-ft, then grouted.



Elevation of reference point: [670.00-ft] (top of casing)
Height of reference point above ground surface [1.42-ft]
Depth of surface seal [0-188-ft]
Type of surface seal: Grout between 6 & 8-in (perforated) casing.
I.D. of surface casing (If present) [8-in]
I.D. of riser pipe: [6 & 8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Packer set: [193-ft]
Depth top of orig perforations: [195-ft]
Description of perforations:
0-188-ft, 2 cuts/rd
195-245-ft, not documented
260-285-ft, not documented
Depth bottom of perforations: [285-ft]
Depth bottom of casing: [304.5-ft]
Depth bottom of borehole: [307-ft]

Drawing By: RKL/ZW22-02.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-2

WELL DESIGNATION	:	299-W22-2
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,429 W 75,221 [200W-06May91]
LAMBERT COORDINATES	:	N 440,438 E 2,220,013 [HANCONV]
		N 134,260.46m E 566,970.93m [NAD83-06May91]
DATE DRILLED	:	May56
DEPTH DRILLED (GS)	:	307-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	209-ft, May56; 205.2-ft, Dec91
CASING DIAMETER	:	6-in carbon steel, +1.42~193-ft; 8-in carbon steel, ~+1.0~304.5-ft
ELEV TOP CASING	:	668.32-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	666.90-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	8-in casing, 0~188-ft, 195~245-ft and 260~285-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 6 and 8-in carbon steel casing. 2-ft pad. No posts, capped, not locked. Identification stamped on brass cap in pad. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured, 11May91 and 03Dec91; PNL Annual, WHC Quarterly sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Chausse
Drilling Company: Not documented
Date Started: 18Jan56

Sample Method: Hard tool (nom)
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 14Feb56

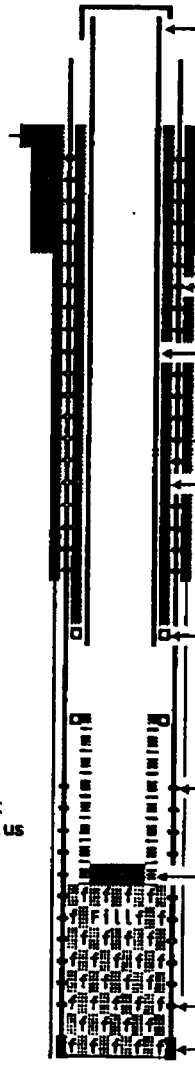
WELL NUMBER: 299-W22-6
TEMPORARY WELL NO: 241-S-15
Hanford Coordinates: N/S N 35,412 E/W W 73,380
State Coordinates: N 440,525 E 2,221,854
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): 665.0 Estimated

Depth to water: 209-ft Feb56
(Ground surface)

GENERALIZED STRATIGRAPHY / Driller's Log

0-17: SAND, SILT and GRAVEL
17-38: SAND-SILT
38-40: GRAVEL-SAND-SILT
40-48: GRAVEL
48-55: Black SAND
55-76: SAND-SILT
76-106: SAND, SILT, CLAY
106-142: CLAY-SAND-SILT
142-150: SAND-SILT-CLAY
150-180: GRAVEL
(Added bentonite @ 164-ft)
180-196: SAND, SILT, GRAVEL
196-231: GRAVEL
231-232: SAND-SILT-GRAVEL water
232-236: GRAVEL
236-274: SAND-SILT-GRAVEL

REMEDIATIONS:
Jan62 by Owens
Sand pumped well, sediment had 600 c/m contamination.
Jun-Jul67 by Bigham and Hatch
Set 59-ft KAIWELL liner. Pulled liner and set screen to ~229-ft. Apparent breaks in casing @ 229 & 242-ft.
May80 by Bultena
Cleaned well. Perforated 0-145-ft and set 6-in liner. Grouted annulus between 6-8-in casing and 0-20-ft around top of 8-in casing.



Elevation of reference point: (top of casing) [666.52-ft]
Height of reference point above ground surface [1.56-ft]
Depth of surface seal [0-145-ft]
Type of surface seal: Grout between 6 & 8-in (perforated) casing.
I.D. of surface casing (if present) [8-in]
8-in casing perforated 0-145-ft, 2 cuts/rd
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Packer set at 150-ft
Depth top of orig perforations: [194-ft]
Description of perforations: 194-213-ft, 6 holes/ft; 213-273-ft, 1 hole/ft spiral
Slotted screen 170-229-ft with plug @ 228-ft
Depth bottom of perforations: [273-ft]
Depth bottom of casing: [274-ft]
Depth bottom of borehole:

Drawing By: RKL/2#W22-06 ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-5

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-6

WELL DESIGNATION	:	299-W22-6
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,412 W 73,380
LAMBERT COORDINATES	:	N 440,525 E 2,221,854 [HANCONV]
DATE DRILLED	:	Feb56
DEPTH DRILLED (GS)	:	274-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	209-ft, Feb56;
CASING DIAMETER	:	6-in carbon steel, +1.56-150-ft; 8-in carbon steel, ~+1.0-274-ft
ELEV TOP CASING	:	666.52-ft
ELEV GROUND SURFACE	:	665.0-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 0-145, 194-273-ft
SCREENED INTERVAL	:	170-229-ft
COMMENTS	:	FIELD INSPECTION, 19May92, 6 and 8-in carbon steel casing. 2-ft pad. No posts, capped, not locked. No permanent identification. Brass cap in pad not stamped. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Chausse
Drilling Company: Not documented
Date Started: 11May56
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 12Jun56

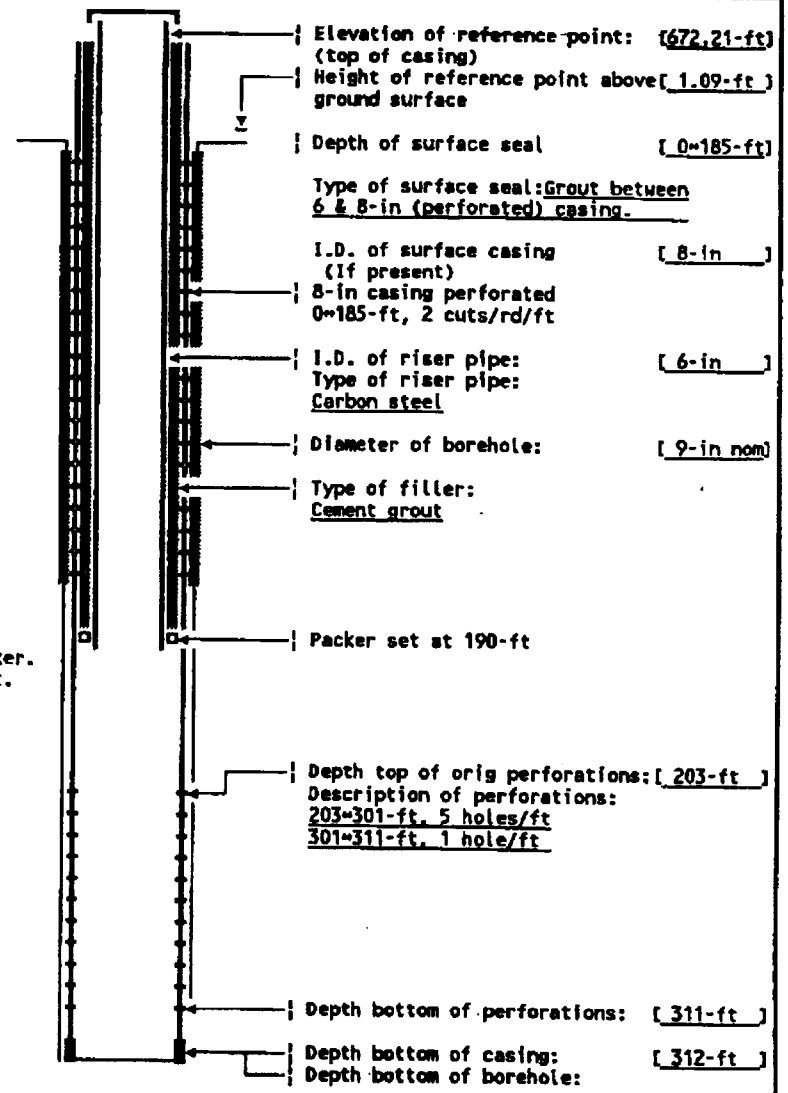
WELL NUMBER: 299-W22-10
TEMPORARY WELL NO: 241-S-19
Hanford Coordinates: N/S N 35,314 E/W W 75,115
State Coordinates: N 440,423 E 2,220,120
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 671.1 Estimated

Depth to water: 220-ft Jun56
(Ground surface) 207-ft Apr90

GENERALIZED STRATIGRAPHY / Driller's Log

0-45: SAND, SILT and GRAVEL
45-55: GRAVEL
55-60: SAND, SILT and GRAVEL
60-138: SAND, SILT
Encountered contamination @ 110-ft, 4,000 cts
138-232: GRAVEL
218-ft, 2,000 cts
232-250: SAND-GRAVEL
250-ft, 25,000 cts
250-276: SAND-GRAVEL
276-279: SAND-GRAVEL-BOULDERS
270-312: SAND-GRAVEL

REMEDIATIONS:
Mar87 by Garcia;
Perforated 8-in casing 0-185-ft.
Set 6-in casing to 190-ft on packer.
Grouted annulus w/127-gals cement.



Drawing By: RKL/2#W22-10 ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-7

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-10

WELL DESIGNATION	:	299-W22-10
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,314 W 75,115
LAMBERT COORDINATES	:	N 440,423 E 2,220,120 [HANCONV]
DATE DRILLED	:	Jun56
DEPTH DRILLED (GS)	:	312-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	220-ft, Jun56; 207.0-ft, 02Apr90
CASING DIAMETER	:	6-in carbon steel, +1.09-190-ft; 8-in carbon steel, +1.0-312-ft
ELEV TOP CASING	:	672.21-ft
ELEV GROUND SURFACE	:	671.1-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 0-185, 203-311-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 6 and 8-in carbon steel casing. No pad, No posts, capped and locked. No permanent identification. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	One water level, 02Apr90; PNL Annual, WHC Quarterly water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Row/Richards
Drilling Company: Not documented
Date Started: 25May56

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 13Jun56

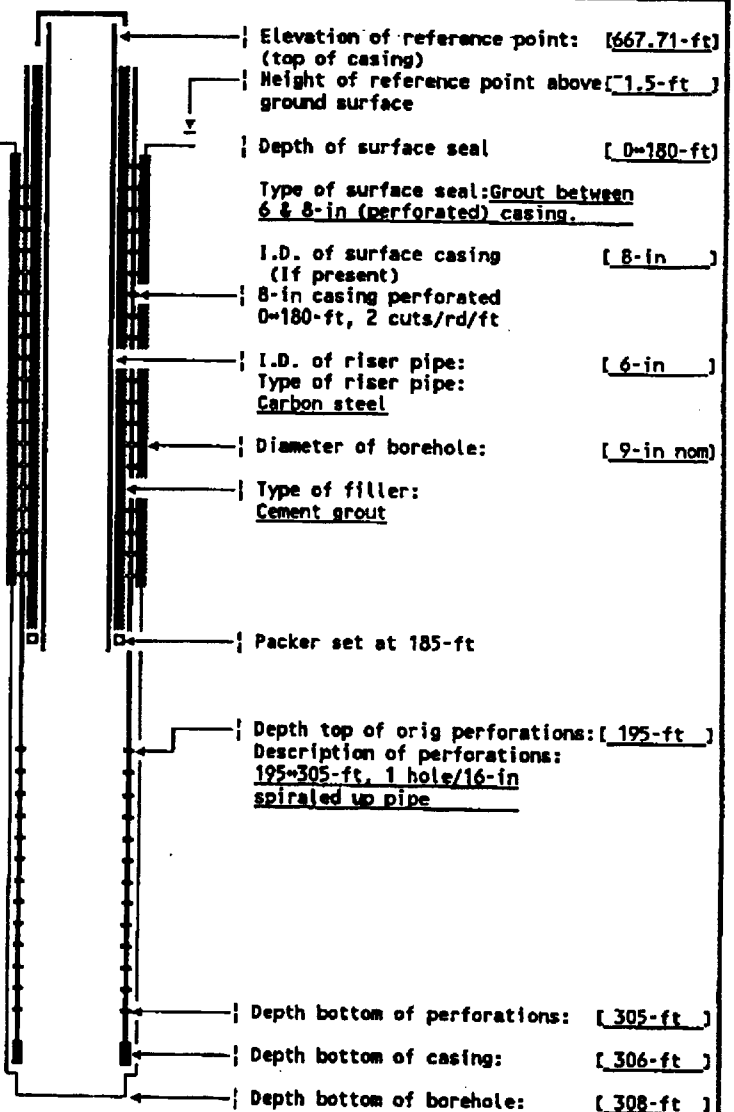
WELL NUMBER: 299-W22-11
TEMPORARY WELL NO: 241-S-20
Hanford Coordinates: N/S N 35,450 E/W W 75,277
State Coordinates: N 440,539 E 2,219,957
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 666.2 Estimated

Depth to water: 206-ft May56
(Ground surface) 195-ft Sep71

GENERALIZED STRATIGRAPHY / Driller's Log

0-10: TOPSOIL and SAND
10-40: SAND-SILT
40-42: SAND-GRAVEL, very little SILT
42-45: SAND-GRAVEL
45-48: ROCK & SAND
48-50: ROCK & SAND, SILT
50-56: SAND, GRAVEL, little SILT
56-64: SAND, very little SILT & GRAVEL
64-106: SAND-SILT
106-148: SAND, heavy SILT
148-152: SAND-CALICHE-GRAVEL
152-158: SAND-GRAVEL-some SILT
158-192: GRAVEL-SAND, some SILT
192-194: GRAVEL, SAND, little SILT
194-198: GRAVEL, SAND
198-218: GRAVEL
218-230: SAND-GRAVEL
230-232: Pure GRAVEL
232-246: GRAVEL & SAND
246-278: SAND
278-280: SAND, GRAVEL & SILT
280-286: GRAVEL & SAND
286-288: GRAVEL & SAND, more SILT
288-292: SAND, some SILT
292-294: SAND
294-308: SAND, GRAVEL, some SILT

REMEDIATION:
Jun80 by Bultena
Pulled piezometers and cleaned to 308-ft. Perforated 0-180-ft. Set 6-in liner to 185-ft on packer. Placed sand on packer. Grouted annulus between 6-8-in casing w/248-gals grout.



Drawing By: RKL/2WW22-11 ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-11

WELL DESIGNATION	:	299-W22-11
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,450 W 75,277
LAMBERT COORDINATES	:	N 440,539 E 2,219,957
DATE DRILLED	:	Jun56
DEPTH DRILLED (GS)	:	308-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	206-ft, May56;
(TOC)	:	196.8-ft, 14Sep71
CASING DIAMETER	:	6-in carbon steel, +WD-185-ft;
		8-in carbon steel, +WD-306-ft
ELEV TOP CASING	:	667.71-ft
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	8-in casing, 0-180, 195-305-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured, 29Aug56-14Sep71;
		Not on water sample schedule
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Gentz
Drilling Company: Not documented
Date Started: 07Jun56

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 13Jul56

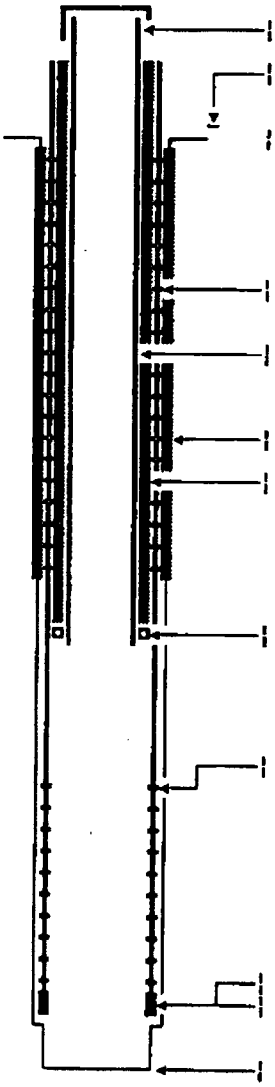
WELL NUMBER: 299-W22-15
TEMPORARY WELL NO: 241-S-21
Hanford Coordinates: N/S N 35,507 E/W W 75,182
State Coordinates: N 440,616 E 2,220,052
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): Not documented

Depth to water: 202-ft Jul56
(Ground surface) ___

GENERALIZED STRATIGRAPHY / Driller's Log

0-15: SAND
15-20: SAND, little GRAVEL
20-42: SAND
42-52: GRAVEL
Contamination encountered @ 52-ft, 40,000 cts
52-60: SAND
60-68: SAND, GRAVEL, little SILT
68-86: SAND, little SILT
86-136: SAND & SILT
136-146: SAND, SILT, little CLAY
146-154: SAND & SILT
154-160: SAND and GRAVEL
160-162: GRAVEL and SAND
162-166: SAND and SILT
166-174: SAND, some GRAVEL
174-188: SAND and GRAVEL
188-194: GRAVEL
194-196: GRAVEL, little SILT
196-210: COBBLES and GRAVEL
210-230: GRAVEL and SAND
230-236: GRAVEL, SAND and SILT
236-250: GRAVEL and SAND
250-254: SAND and GRAVEL
254-265: COBBLES, GRAVEL and SAND
265-268: SAND and GRAVEL

REMEDIATION:
Jun80 by Bultena
Cleaned well to 268-ft.
Perforated 8-in casing and set 6-in liner to 198-ft.
Grouted annulus with 220-gals cement.



Elevation of reference point: [672.00-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-195-ft]
Type of surface seal: Grout between 6 & 8-in (perforated) casing,
I.D. of surface casing (If present) [8-in]
8-in casing perforated 0-195-ft, 2 cuts/rd/ft
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Packer set at 198-ft
Depth top of orig perforations: [190-ft]
Description of perforations: 190-220-ft, 5 holes/ft; 220-265-ft, 1 hole/ft
Depth bottom of perforations:
Depth bottom of casing: [263-ft]
Depth bottom of borehole: [268-ft]

Drawing By: RKL/2W22-15.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-15

WELL DESIGNATION	:	299-W22-15
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,507 W 75,182
LAMBERT COORDINATES	:	N 440,616 E 2,220,052 [HANCONV]
DATE DRILLED	:	Jul56
DEPTH DRILLED (GS)	:	268-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	202-ft, Jun56;
CASING DIAMETER	:	6-in carbon steel, +ND-198-ft; 8-in carbon steel, +ND-263-ft
ELEV TOP CASING	:	672.00-ft
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	8-in casing, 0-195, 190-263-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Row/Richards
Drilling Company: Not documented
Date Started: 15Jun56
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 24Jul56

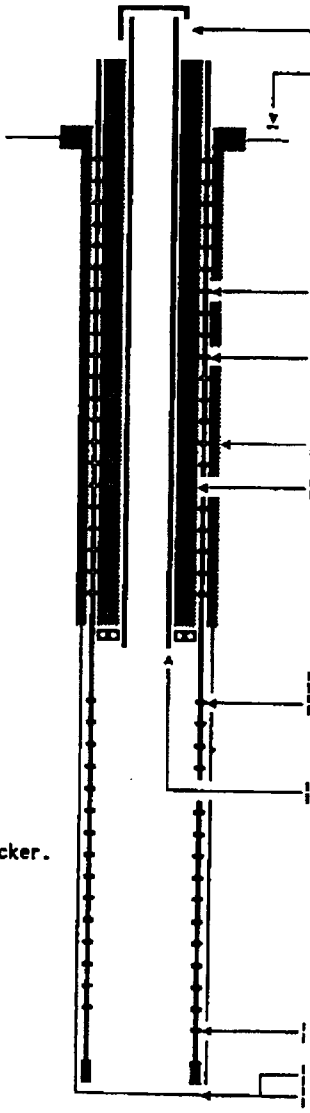
WELL NUMBER: 299-W22-16
TEMPORARY WELL NO: 241-S-22
Hanford Coordinates: N/S N 35,335 E/W W 75,209
State Coordinates: N 440,444 E 2,220,025
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 670.4 Estimated

Depth to water: 198-ft Jul56 (Ground surface)

GENERALIZED STRATIGRAPHY / Driller's Log

0-10: TOP SOIL-SAND
10-15: SAND, some SILT
15-25: SAND, small GRAVEL
25-45: SAND
45-55: SAND-GRAVEL
55-136: SAND-SILT
136-152: SAND, GRAVEL, SILT
152-168: SAND, SILT, GRAVEL
168-186: SAND
186-190: GRAVEL & SAND
190-197: SAND and GRAVEL
197-205: BOULDERS
205-240: SAND and GRAVEL
240-248: Fine SAND

REMEDIATION:
May78 by Evans
Perforated 0-180-ft.
Set 4-in liner to 185-ft on packer.
Grouted annulus between 4-8-in casing.



Elevation of reference point: [672.00-ft] (top of casing)
Height of reference point above ground surface [1.6-ft]
Depth of surface seal [0-180-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
Perforated 0-180-ft 2 cuts/rd/ft
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Depth top of perforations: [190-ft]
Description of perforations: 190-246-ft, 5 holes/ft, round
4-in liner set to 185-ft on packer.
Depth bottom of perforations: [246-ft]
Depth bottom of casing:
Depth bottom of borehole: [248-ft]

Drawing By: RKL/2W22-16.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-16

WELL DESIGNATION	:	299-W22-16
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,335 W 75,209
LAMBERT COORDINATES	:	N 440,444 E 2,220,025 [HANCONV]
DATE DRILLED	:	Jul56
DEPTH DRILLED (GS)	:	248-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	198-ft, Jul56;
CASING DIAMETER	:	8-in carbon steel, +1.4-248-ft; 4-in carbon steel, +1.6-185-ft
ELEV TOP CASING	:	672.00-ft
ELEV GROUND SURFACE	:	670.4-ft
PERFORATED INTERVAL	:	8-in casing, 0-180, 190-246-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 4 and 8-in carbon steel casing. 2-ft cement pad. No posts, capped, not locked. No permanent identification. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Wall/Richards, Chausse
Drilling Company: Not documented
Date Started: 25Jul56

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 23Aug56

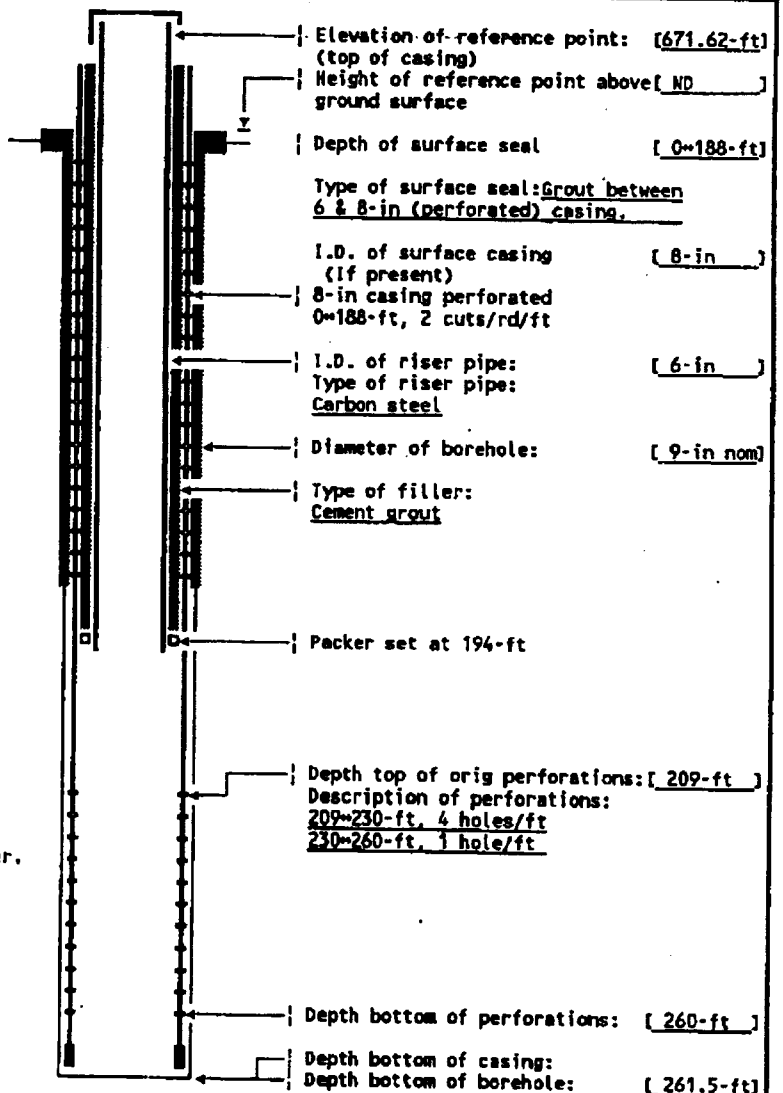
WELL NUMBER: 299-W22-17
TEMPORARY WELL NO: 241-S-23
Hanford Coordinates: N/S N 35,534 E/W W 75,082
State Coordinates: N 440,643 E 2,220,152
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): 669.8 Estimated

Depth to water: 207-ft Aug56
(Ground surface) Dry 04Dec92

GENERALIZED STRATIGRAPHY / Driller's Log

0-20: TOP SOIL
20-27: SAND and BOULDERS
27-41: SAND
41-60: GRAVEL
60-149: SAND-SILT
Contamination encountered @ 130-ft, 1,000 cpm
149-156: SAND-SILT-GRAVEL
156-197: SAND-GRAVEL
Radioactivity stopped @ 194-ft
197-214: SAND-SILT-GRAVEL
214-228: SAND-GRAVEL
228-231: SAND-GRAVEL-SILT
231-256: SAND-GRAVEL
256-261: SAND-SILT-GRAVEL

REMEDIATION:
Jun80 by Bultena
Cleaned on well but sand kept coming in.
Perforated well and set 6-in liner.
Grouted annulus with 230-gals cement.



Drawing By: RKL/2W22-17.ASB Date: 20Apr93

Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-17

WELL DESIGNATION	:	299-W22-17
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,534 W 75,082
LAMBERT COORDINATES	:	N 440,643 E 2,220,152
DATE DRILLED	:	Aug56
DEPTH DRILLED (GS)	:	261.5-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	207-ft, Aug56; 208.6-ft, 11Jun92; Dry, 04Dec92
CASING DIAMETER	:	6-in carbon steel, +1.78-194-ft; 8-in carbon steel, +1.5-261.5-ft
ELEV TOP CASING	:	671.62-ft
ELEV GROUND SURFACE	:	669.8-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 0-188, 209-260-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 6 and 8-in carbon steel casing. 2-ft cement pad, (damaged). No posts, capped and locked. No permanent identification. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Separations area water level measurement, 29Aug56-04Dec92; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Gentz/Chausse
Drilling Company: Not documented
Date Started: 25Aug55/12Jun56

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 01Sep55/02Jul56

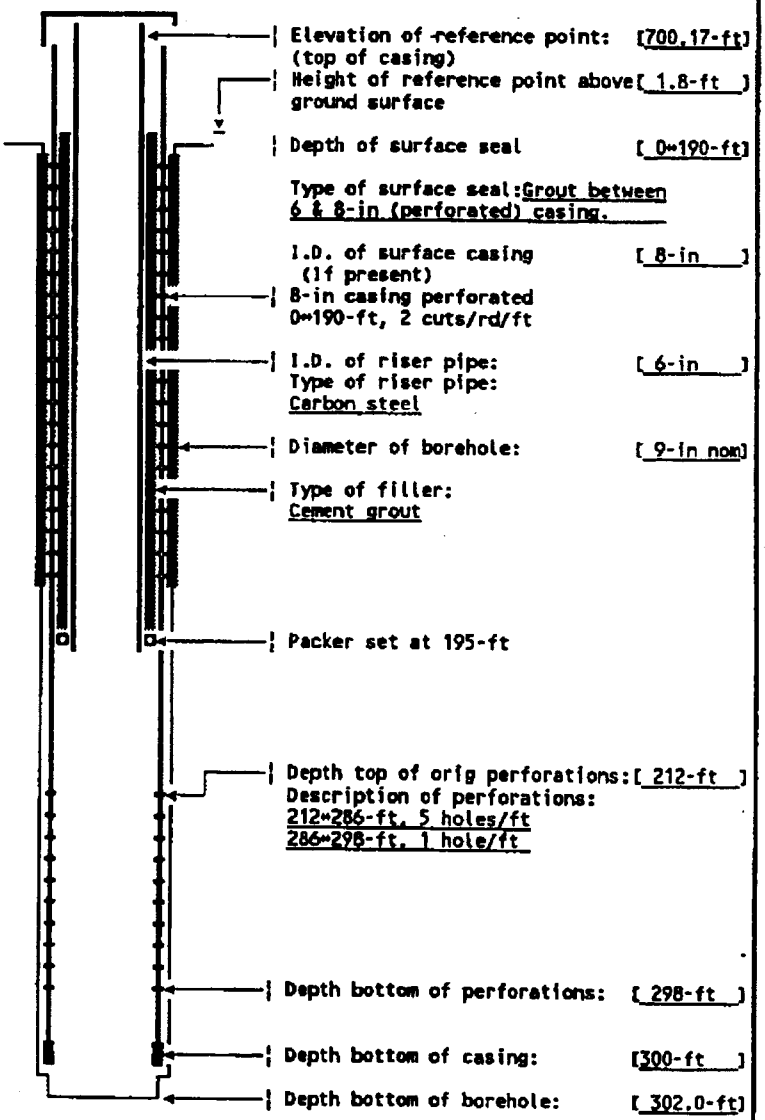
WELL NUMBER: 299-W22-18
TEMPORARY WELL NO: 699-W22-64
241-S-13
Hanford Coordinates: N/S N 35,429 E/W W 75,094
State Coordinates: N 440,538 E 2,220,140
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 698.4 Estimated

Depth to water: 222-ft Jul56
(Ground surface) 206.2-ft Jan91

GENERALIZED STRATIGRAPHY / Driller's Log

0-15: SAND
15-25: SAND and GRAVEL
25-45: SAND
44-50: GRAVEL
50-55: GRAVEL and SAND
55-80: SAND
▲DRILLING STOPPED Sep55▲
▼DRILLING RESTARTED Jun56▼
80-148: SAND-SILT
148-156: SAND, GRAVEL
156-159: GRAVEL-SAND
159-175: SAND
175-302: SAND-GRAVEL

REMEDIATION:
May80 by Bultena
Perforated 0-190-ft.
Set 6-in liner to 195-ft.
Grouted annulus between 6-8-in casing w/248-gals cement.



Drawing By: RKL/2W22-18.ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-17

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-18

WELL DESIGNATION	:	299-W22-18
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,429 W 75,094
LAMBERT COORDINATES	:	N 440,538 E 2,220,140 [HANCONV]
DATE DRILLED	:	Jul56
DEPTH DRILLED (GS)	:	302-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	222-ft, Jul56; 206.2-ft, 08Jan91
CASING DIAMETER	:	6-in carbon steel, +1.8-195-ft; 8-in carbon steel, +-1.5-300-ft
ELEV TOP CASING	:	700.17-ft
ELEV GROUND SURFACE	:	698.4-ft, Estimated
PERFORATED INTERVAL	:	8-in casing, 0-190, 212-298-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 6 and 8-in carbon steel casing. No pad, No posts, capped and locked. No permanent identification. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	One water level measurement, 08Jan91; PNL Annual, WHC Quarterly water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Bigham
Drilling Company: Hatch Drilling Co.
Date Started: 22Feb66

Sample Method: Drive barrel
Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 16Mar66

WELL NUMBER: 299-W22-29
TEMPORARY WELL NO: 299-W22-1A
Hanford Coordinates: N/S N 35,428 E/W W 75,195
State Coordinates: N 440,537 E 2,220,039
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): Not documented

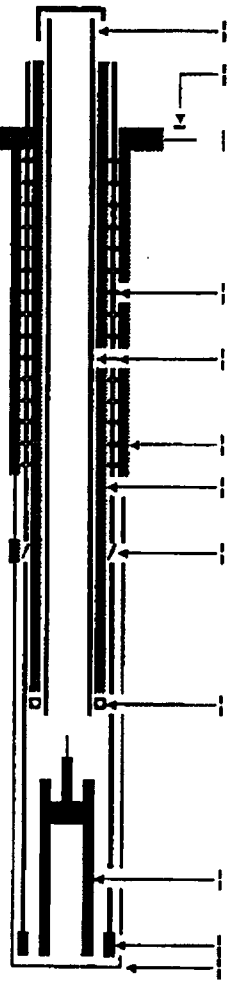
Depth to water: Dry
(Ground surface)

GENERALIZED STRATIGRAPHY / Driller's Log

0-85: GRAVEL & SAND
85-135: SAND
135-150: SAND and SILT, coarse GRAV EL
150-170: GRAVEL and SAND
170-185: BOULDERS, SAND & GRAVEL
185-192: ROCK
192-202: COBBLES
202 : SAND and COBBLES

DRILLER'S NOTES:
Line broke @ 192-ft.
Fished for tools but
casing crimped and tools
hung up. Hole abandoned.

REMEDIATION:
Jul80 by Bultena;
Found broken weld in casing
@ 106-ft.
Perforated 0-100-ft.
Set 4-in liner to 168-ft and
grouted w/168-gals cement.



Elevation of reference point: [668.53-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-100-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
Perforated 0-100-ft 2 cuts/rd/ft
I.D. of riser pipe: [4 & 6-in] Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
Broken weld in casing 106-ft
4-in liner set to 168-ft on packer. Annulus between 4-6-in casing grouted.
Drive tools apparently lost in hole. Hole abandoned
Depth bottom of casing: [ND]
Depth bottom of borehole: [202-ft]

Drawing By: RKL/2W22-29.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-29

WELL DESIGNATION	:	299-W22-29
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,428 W 75,195
LAMBERT COORDINATES	:	N 440,537 E 2,220,039 [HANCONV]
DATE DRILLED	:	Mar66
DEPTH DRILLED (GS)	:	202-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	Not applicable
CASING DIAMETER	:	6-in carbon steel, ~0.8~200-ft; 4-in carbon steel, +1.0~168-ft
ELEV TOP CASING	:	668.53-ft
ELEV GROUND SURFACE	:	667.5-ft, Estimated
PERFORATED INTERVAL	:	0~100-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 4 and 6-in carbon steel casing. 2-ft cement pad. No posts, capped, not locked. No permanent identification, (brass cap not stamped). In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: D. Bigham/L. Bultena
Drilling Company: Hatch Drilling Co.
Date Started: 17Mar66/02Jan80

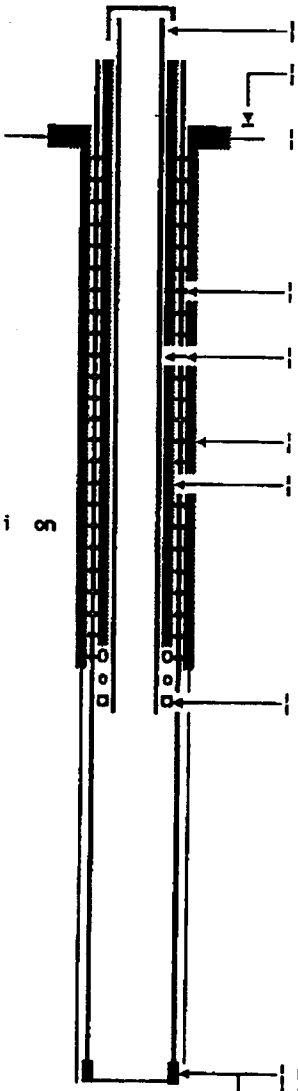
Sample Method: Drive barrel
Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 01Apr66/16Jul80

WELL NUMBER: 299-W22-30
TEMPORARY WELL NO: 299-W22-3A
Hanford Coordinates: N/S N 35,411 E/W W 75,165
State Coordinates: N 440,520 E 2,220,069
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): 666.7 Estimated

Depth to water: 196-ft Mar66
(Ground surface)

GENERALIZED STRATIGRAPHY / Driller's Log

0-35: SAND, GRAVEL
35-40: SAND
40-45: SAND & GRAVEL
45-146: SAND & SILT
146-160: SAND & COBBLES
160-185: SAND, GRAVEL, COBBLES
185-191: SAND, COBBLES, BOULDERS
191-200: SAND, GRAVEL, COBBLES
200-207: SAND, GRAVEL
▲DRILLING STOPPED, 01Apr66 ▲
▼DRILLING RESTARTED, 02Jan80 ▼
203-219: Brown SAND & GRAVEL
219-221: Compacted SAND & GRAVEL
221-224: GRAVEL & SAND
224-231: GRAVEL, SILT & SAND
Encountered contamination:
203-210, sample was 80,000 cpm
210-219, drilling in contaminati on



Elevation of reference point: [669.33-ft] (top of casing)
Height of reference point above ground surface [2.6-ft]
Depth of surface seal [0-185-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
Perforated 0-185-ft 2 cuts/rd/ft
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
4-in liner set to 190-ft on packer. Placed sand and 2 sacks grout. Grout disappeared. Bailed sludge which was 20,000 cpm. Placed ½-in, then ¾-in gravel in annulus and grouted.
Depth bottom of casing: [231-ft]
Depth bottom of borehole: [231-ft]

Drawing By: RKL/2W22-30.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-30

WELL DESIGNATION	:	299-W22-30
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,411 W 75,165
LAMBERT COORDINATES	:	N 440,520 E 2,220,069 [HANCONV]
DATE DRILLED	:	Apr66/Jul80
DEPTH DRILLED (GS)	:	207/231-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196-ft, Mar66;
CASING DIAMETER	:	6-in carbon steel, +2.2-231-ft; 4-in carbon steel, +2.6-190-ft
ELEV TOP CASING	:	669.33-ft
ELEV GROUND SURFACE	:	666.73-ft, Estimated
PERFORATED INTERVAL	:	0-185-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 4 and 6-in carbon steel casing. 2-ft pad, no posts, capped, not locked. Identification not stamped on brass marker in pad. In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: D. Bigham/L. Bultena
Drilling Company: Hatch Drilling Co.
Date Started: 04Apr66/17Dec79

Sample Method: Drive barrel
Hard tool
Drilling Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 20Apr66/11Jul80

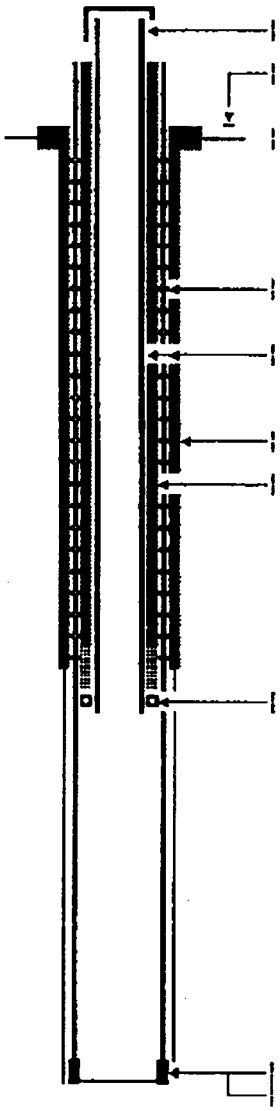
WELL NUMBER: 299-W22-31
TEMPORARY WELL NO: 299-W22-18
Hanford Coordinates: N/S N 35,446 E/W W 75,198
State Coordinates: N 440,555 E 2,220,036
Start Card #: Not documented T ___ R ___ S ___
Elevation Ground surface (ft): Not documented

Depth to water: 196-ft Apr66 (Ground surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-35: SAND, GRAVEL, COBBLES
35-146: SAND, SILT
146-202: SAND, COBBLES
202-206: SAND, GRAVEL
▲DRILLING STOPPED, 20Apr66 ▲
▼DRILLING RESTARTED, 18Dec79 ▼
207-210: GRAVEL, SILT & SAND
210-214: GRAVEL, SAND & SILT
214-219: SAND, SILT & GRAVEL
219-225: SAND & GRAVEL
225-227: SAND, SILT & GRAVEL
227-242: GRAVEL & SAND
242-250: SAND & GRAVEL

REMEDIATION:
Dec79-Jul80 by L. Bultena;
Perforated 0-185-ft.
Perforator became contaminated.
Ran 4-in liner to 190-ft
and grouted annulus
with 149-gals cement.



Elevation of reference point: [668.87-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-185-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (if present) [ND]
Perforated 0-185-ft 2 cuts/rd/ft
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
4-in liner set to 190-ft on packer. Placed sand and 2 sacks grout. Grout went past packer to water. Placed more sand, then grouted annulus.
Depth bottom of casing: [250-ft]
Depth bottom of borehole: [250-ft]

Drawing By: RKL/2W22-31.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-31

WELL DESIGNATION	:	299-W22-31
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,446 W 75,198
LAMBERT COORDINATES	:	N 440,555 E 2,220,036 [HANCONV]
DATE DRILLED	:	Apr66/Jul80
DEPTH DRILLED (GS)	:	231/250-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196-ft, Apr66
CASING DIAMETER	:	6-in carbon steel, +ND-250-ft; 4-in carbon steel, +ND-190-ft
ELEV TOP CASING	:	668.87-ft
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	0-185-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: D. Bigham
Drilling Company: Hatch Drilling Co.
Date Started: 27Sep66

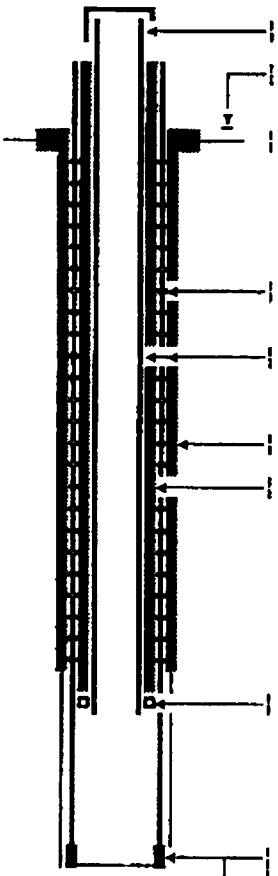
Sample Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 25Oct66

WELL NUMBER: 299-W22-36
TEMPORARY WELL NO: 299-W22-1C
Hanford Coordinates: N/S N 35,455 E/W W 75,221
State Coordinates: N 440,564 E 2,220,013
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 667.2 Estimated

Depth to water: 196-ft Oct66 (Ground surface)

GENERALIZED STRATIGRAPHY — Driller's Log

0-20: Not documented
20-30: SAND, SILT, GRAVEL
30-45: GRAVEL, COBBLES
45-125: Not documented
125-145: Hard CLAY, SILT
145-160: GRAVEL, ROCKS
160-170: ROCKS, GRAVEL
170-206: GRAVEL, ROCKS



Elevation of reference point: [668.65-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-185-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
Perforated 0-185-ft, 2 cuts/rd/ft
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
4-in liner set to 190-ft on packer. Placed 2 sacks grout. Grouted annulus between 4-6-in casings.
Depth bottom of casing: [206-ft]
Depth bottom of borehole: [206-ft]

REMEDIATION:
Jul80 by L. Bultena;
Perforated 0-185-ft.
Perforator became contaminated.
Ran 4-in liner to 190-ft and grouted annulus.

Drawing By: RKL/2W22-36.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-36

WELL DESIGNATION	:	299-W22-36
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,455 W 75,221
LAMBERT COORDINATES	:	N 440,564 E 2,220,013 [HANCONV]
DATE DRILLED	:	Oct66
DEPTH DRILLED (GS)	:	206-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196-ft, Oct66;
CASING DIAMETER	:	6-in carbon steel, +ND-206-ft; 4-in carbon steel, +1.4-190-ft
ELEV TOP CASING	:	668.65-ft
ELEV GROUND SURFACE	:	667.2-ft, Estimated
PERFORATED INTERVAL	:	0-185-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 19May92, 4 and 6-in carbon steel casing. 2-ft cement pad. No posts, capped, not locked. No permanent identification. (Not stamped on brass cap). In surface radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	No water level data; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Gentz
Drilling Company: Not documented
Date Started: 28Apr52
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 03Jun52

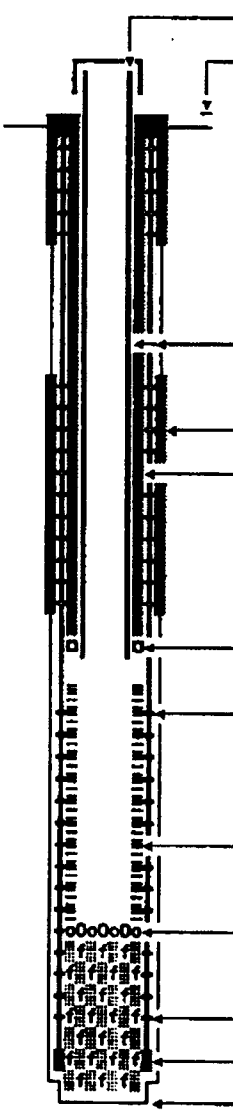
WELL NUMBER: 299-W23-1
TEMPORARY WELL NO: 241-S-6
Hanford Coordinates: N/S W 35,970 E/W W 75,615
State NAD83 N 134,425.07m E 566,850.44m
Coordinates: N 441,678 E 2,219,618
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 665.66 Brass cap

Depth to water: 190-ft Jun52
(Ground surface) 204.2-ft, 26Mar93

GENERALIZED STRATIGRAPHY / Driller's Log

0-10: SAND & GRAVEL
10-45: BACKFILL
45-50: SAND & GRAVEL
50-59: GRAVEL
59-135: SAND & SILT
135-140: Heavy SILT
140-145: CLAY, SILT & SAND
145-157: CLAY & SILT
157-163: GRAVEL
163-175: GRAVEL, SAND & SILT
175-200: GRAVEL & SAND
200-205: GRAVEL & ROCK up to 5-in
205-210: GRAVEL & SAND
210-230: GRAVEL, SAND & SILT
240-255: SAND & GRAVEL & SILT
255-260: Coarse GRAVEL & SAND
260-262: SAND & GRAVEL

REMEDIATION: Sep67, by Hatch
Perforated 6-in casing 180-190-ft
Installed 6-in screen
Feb76, by Hatch
Perforated 6-in casing 0-20 and 90-170-ft
Installed 4-in casing to 175-ft and grouted annulus



Elevation of reference point: [666.14-ft] (top of casing)
Height of reference point above ground surface [0.48-ft]
Depth of surface seal [0-20-ft]
Type of surface seal: Grout between 4 & 6-in (perforated) casing.
I.D. of surface casing (if present) [6-in]
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
Packer set: [175-ft]
Depth top of orig perforations: [180-ft]
Description of perforations:
0-20 & 90-170-ft, 2 cuts/rd/ft
180-190-ft, not documented
195-260-ft, 5 holes/ft
6-in telescoping screen
178-234.5-ft
Top 189-ft by TV
Gravel plug, 234.5-240-ft
Depth bottom of perforations: [260-ft]
Depth bottom of casing: [261-ft]
Depth bottom of borehole: [262-ft]

Drawing By: RKL/2W23-01.ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-27

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-1

WELL DESIGNATION	:	299-W23-1
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,970 W 75,615 [200W-06May91]
LAMBERT COORDINATES	:	N 441,678 E 2,219,618 [HANCONV]
		N 134,425.07m E 566,850.44m [NAD83-06May91]
DATE DRILLED	:	Jun52
DEPTH DRILLED (GS)	:	262-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	190-ft, Jun52;
		204.2-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +0.48~175-ft;
		6-in carbon steel, ~0~261-ft
ELEV TOP CASING	:	666.14-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	665.66-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	6-in casing, 0~20, 90~170, 180~190 and 195~260-ft
SCREENED INTERVAL	:	178~234.5-ft, 6-in telescoping
COMMENTS	:	FIELD INSPECTION, 09Feb90,
		4-in carbon steel casing.
		No pad, no posts, capped and locked.
		No permanent identification.
		Identification stamped on brass marker.
		In underground radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 25Jun53~26Mar93;
		PNL Annual, WHC Quarterly and Semiannual water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Gentz
Drilling Company: Not documented
Date Started: 27Aug54

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 09Sep54

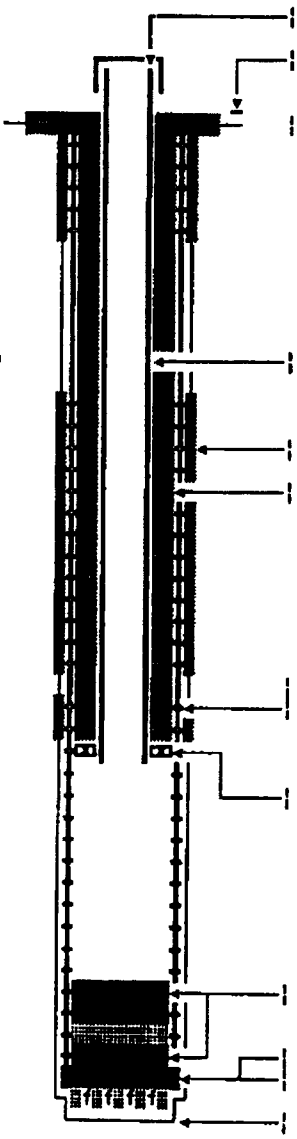
WELL NUMBER: 299-W23-2
TEMPORARY WELL NO: 241-SX-5
Hanford Coordinates: N/S N 35,425 E/W W 75,605
State NAD83 N 134,258.91m E 566,854.15m
Coordinates: N 440,533 E 2,219,629
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 662.95 Brass cap

Depth to water: 204-ft Sep54
(Ground surface): 202.7-ft 26Mar93

GENERALIZED STRATIGRAPHY / Driller's Log

0-2: Coarse GRAVEL
2-50: SAND & little SILT, BACKFILL
50-53: SAND, SILT and small GRAVEL
53-58: Coarse GRAVEL little SAND
58-70: SAND, little SILT
70-75: SAND, SILT and CLAY
75-135: SAND and SILT
135-157: SAND, SILT and CLAY
157-165: Small and coarse GRAVEL
165-175: SAND, GRAVEL and SILT
175-180: Coarse GRAVEL, little SAND
180-185: SAND, GRAVEL, little SILT
185-205: SAND and GRAVEL
205-220: GRAVEL, SAND, some SILT
220-236: GRAVEL and SAND

REMEDIATION:
Jun75, by ?
Placed cement plug 232-235-ft
Sep75, by ?
Placed cement plug 220-226-ft
Mar76, by Hatch
Perforated 0-20 and 90-182-ft, Apparently set 4-in on packer at 187-ft. Annular grouting not documented but assumed at same time.



Elevation of reference point: [663.48-ft] (top of casing)
Height of reference point above ground surface [0.53-ft]
Depth of surface seal [0-20-ft]
Type of surface seal: Grout between 4 & 8-in (perforated) casing 2-ft round collar
I.D. of surface casing [ND]
I.D. of riser pipe: [4 & 8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Depth top of orig perforations: [184-ft]
Description of perforations: 0-20 & 90-182-ft, not documented 184-235-ft, 4 holes/ft
Packer set at 187-ft
Cement plugs, 220-226 and 232-235-ft
Depth bottom of perforations: [235-ft]
Depth bottom of casing: [235-ft]
Depth bottom of borehole: [236-ft]

Drawing By: RKL/2W23-02.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-2

WELL DESIGNATION	:	299-W23-2
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,425 W 75,605 [200W-06May01]
LAMBERT COORDINATES	:	N 440,533 E 2,219,629 [HANCONV]
		N 134,258.91m E 566,854.15m [NAD83-06May91]
DATE DRILLED	:	Sep54
DEPTH DRILLED (GS)	:	236-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	204-ft, Sep54;
		202.7-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +0.53~187-ft;
		8-in carbon steel, ~0~235-ft
ELEV TOP CASING	:	663.48-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	662.95-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	8-in casing, 0~20, 90~182 and 184~235-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 09Feb90,
		4-in carbon steel casing.
		2-ft cement pad. No posts, capped, not locked.
		Identification stamped on brass cap in pad.
		In underground radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	05Mar90 - 4-in liner clean. Perfs begin ~191.2-ft,
		are in bad condition and difficult to see.
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 18Aug55~24Nov92
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Rydman
Drilling Company: Not documented
Date Started: 06Feb56

Sample Method: Hard tool (nom)
Additives Used: Drilling Aid
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 27Feb56

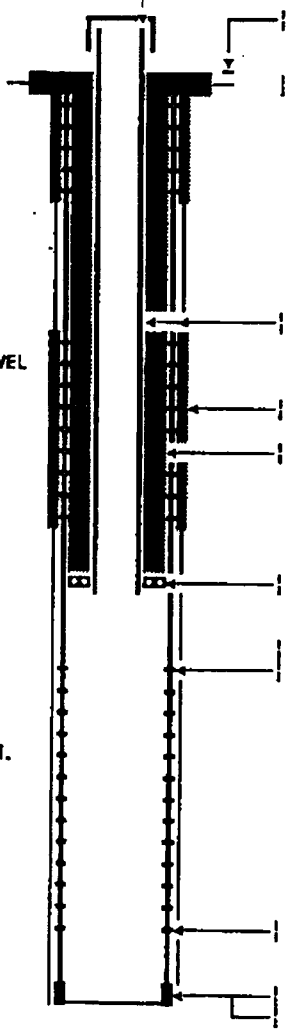
WELL NUMBER: 299-W23-3
TEMPORARY WELL NO: 241-SX-12
Hanford Coordinates: N/S N 35,110 E/W W 75,614
State NAD83 N 134,162.91m E 566,851.34m
Coordinates: N 440,218 E 2,219,621
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 663.07 Brass cap

Depth to water: 200-ft Feb56.
(Ground surface) 203.8-ft 26Mar93

GENERALIZED STRATIGRAPHY — Driller's Log

0-51: BACKFILL
51-57: Brown SAND
57-61: Coarse SAND and GRAVEL
61-70: Loose SAND and GRAVEL
70-72: Brown SAND
72-78: Brown SAND, some GRAVEL
78-128: Brown SAND
128-145: Sandy CLAY
145-157: Sandy CLAY, some GRAVEL
157-172: Coarse SAND, some GRAVEL
172-206: BOULDERS. GRAVEL and SAND, small amount SILT
206-232: Water bearing SAND and GRAVEL

REMEDIATION:
Mar76, by Hatch
Perforated 0-20, 90-165-ft
Set 4-in casing on packer to 170-ft. Grouting between 4 and 8-in casing not documented. Assumed done at that time.



Elevation of reference point: [663.56-ft] (top of casing)
Height of reference point above ground surface [0.49-ft]
Depth of surface seal [0-20-ft]
Type of surface seal: Grout between 4 & 8-in (perforated) casing 2-ft round collar
I.D. of surface casing [ND]
I.D. of riser pipe: [4 & 8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in nom]
Type of filler: Cement grout
Packer set: [170-ft]
Depth top of orig perforations: [176-ft]
Description of perforations: 0-20, 90-165 & 176-228-ft Not documented
Depth bottom of perforations: [228-ft]
Depth bottom of casing: [232-ft]
Depth bottom of borehole: [232-ft]

Drawing By: RKL/2W23-03.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-3

WELL DESIGNATION	:	299-W23-3
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,110 W 75,615 [200W-06May91]
LAMBERT COORDINATES	:	N 440,218 E 2,219,620 [HANCONV]
		N 134,162.91m E 566,851.34m [NAD83-06May91]
DATE DRILLED	:	Feb56
DEPTH DRILLED (GS)	:	232-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	200-ft, Feb56; 203.8-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +0.49~170-ft; 8-in carbon steel, ~0~232-ft
ELEV TOP CASING	:	663.56-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	663.07-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	8-in casing, 0~20, 90~165 and 176~228-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 09Feb90, 4-in carbon steel casing. 2-ft pad, no posts, capped and locked. Identification stamped on brass marker in pad. In underground radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	05Mar90 - 4-in liner clean to 105-ft. 8-in casing has a lot of rust/scale. Perfs 188.3-ft~Not documented.
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 24May56~26Mar93; WHC Quarterly water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Gentz
Drilling Company: Not documented
Date Started: 24May57

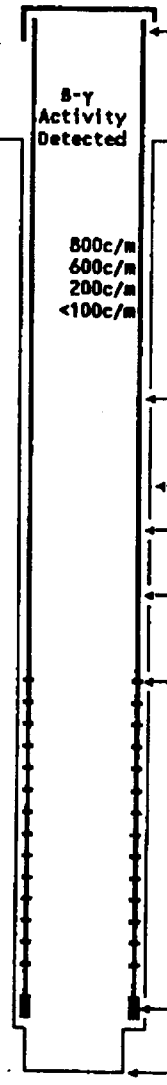
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 18Jun57

WELL NUMBER: 299-W23-4
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,864 E/W W 76,344
State NAD83 N 134,392.22m E 566,628.50m
Coordinates: N 440,970 E 2,218,889
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 661.1 Estimated

Depth to water: 185-ft Jun57
(Ground surface) 197.9-ft 08Dec92

GENERALIZED STRATIGRAPHY / Driller's Log

5: SAND-SILT
10,15: SAND-SILT-COBBLES-GRAVEL
20-30: Coarse SAND-GRAVEL
35: COBBLES-GRAVEL
40: Coarse GRAVEL and SAND
45,50: SAND, SILT, little GRAVEL
55-75: SAND-little SILT
80-100: SAND-SILT
105: SAND-SILT, some GRAVEL
110-118: Coarse GRAVEL, SAND
118-163: SAND-SILT
163-170: SANDSTONE, little GRAVEL
170-180: SAND-SILT and GRAVEL to 3-in
180-185: SAND-GRAVEL
185-190: GRAVEL-SAND, little SILT
195-210: GRAVEL-SAND
210: SAND-GRAVEL, little SILT
215: SAND-GRAVEL
220-225: SAND-GRAVEL, little SILT
225-235: SAND and GRAVEL
240: GRAVEL-SAND, little SILT
245-250: GRAVEL and fine SAND
250-260: COBBLES-SAND-GRAVEL
260: Fine and coarse SAND and GRAVEL up to 4-in
265: Fine and coarse SAND
270-300: COBBLES-GRAVEL and SAND
300 : COBBLES-GRAVEL-SAND little SILT



Elevation of reference point: [662.63-ft] (top of casing)
Height of reference point above ground surface [1.5-ft]
Depth of surface seal [ND]
Type of surface seal: None documented
I.D. of surface casing (If present) [ND]
I.D. of riser pipe: [8-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [9-in]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
Depth top of perforations: [180-ft]
Description of perforations:
180-205-ft, 5 holes/ft
205-220-ft, 3 holes/ft
220-265-ft, 1 hole/ft
270-300-ft, 1 hole/ft*

* Driller only documented ~295-ft of casing in hole. Probably no perforations below 295-ft

Depth bottom of perforations:
Depth bottom of casing: [~295-ft]
Depth bottom of borehole: [300-ft]

Drawing By: RKL/2W23-04.ASB Date: 21Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-4

WELL DESIGNATION	:	299-W23-4
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,864 W 76,344 [200W-06May91]
LAMBERT COORDINATES	:	N 440,970 E 2,218,889 [HANCONV]
		N 134,392.22m E 566,628.50m [NAD83-06May91]
DATE DRILLED	:	Jun57
DEPTH DRILLED (GS)	:	300-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	185-ft, Jun57; 197.9-ft, 08Dec92
CASING DIAMETER	:	8-in carbon steel, +1.54~295-ft
ELEV TOP CASING	:	662.63-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	661.1-ft, Estimated
PERFORATED INTERVAL	:	180~295-ft
SCREENED INTERVAL	:	None documented
COMMENTS	:	FIELD INSPECTION, 08Feb90, 8-in carbon steel casing. No pad, no posts, capped and locked. No permanent identification. Not in radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Separations area Semiannual water level measurement, 27Aug65~08Dec92; PNL Annual; WHC Monthly and Semiannual water sample schedule
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Rodda
Drilling Company: Not documented
Date Started: 15Sep69

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 030ct69

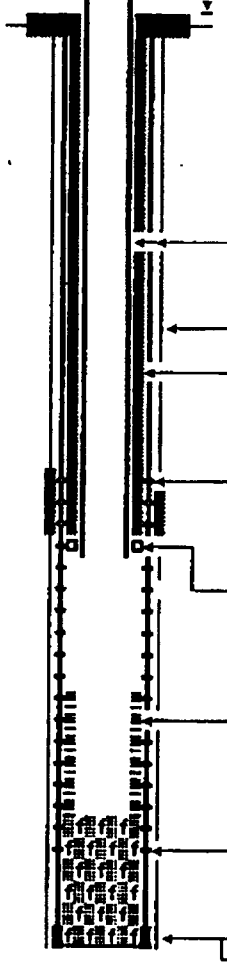
WELL NUMBER: 299-W23-5
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,200 E/W W 75,550
State NAD83 N 134,190.35m E 566,871.01m
Coordinates: N 440,308 E 2,219,685
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 663.68 Brass cap

Depth to water: 186-ft Oct69
(Ground surface) DRY Jan92

GENERALIZED STRATIGRAPHY — Driller's Log

0-2: GRAVEL, SAND and SILT
2-5: CLAY and SAND
5-10: SAND, SILT
10-15: SAND, SILT, and GRAVEL
15-55: SAND and SILT
55-56: Cemented SAND and GRAVEL
56-60: SAND and SILT
60-65: SAND and cemented GRAVEL
65-66: GRAVEL
66-70: SAND and GRAVEL
70-120: SAND and SILT
120-125: SAND, CLAY and SILT
125-135: CLAY
135-150: Sandy CLAY
150-155: GRAVEL
155-167: SAND and CLAY
167-170: SAND
170-250: SAND and GRAVEL

REMEDIATION: Mar76, by Hatch
Installed 4-in casing on packer set at 175-ft. No documentation of perforating.



Elevation of reference point: [664.16-ft] (top of casing)
Height of reference point above ground surface [0.48-ft]
Depth of surface seal [ND]
Type of surface seal: Not documented
I.D. of surface casing (If present) [6-in]
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
Depth top of perforations: [170-ft]
Description of perforations: 6-in. 170-245-ft, 2 holes/rd/ft
No documentation of other perfs
Packer set: [175-ft]
6-in telescoping screen 205-238-ft ?
Depth bottom of perforations: [240-ft]
Depth bottom of casing: [250-ft]
Depth bottom of borehole: [250-ft]

Drawing By: RKL/2W23-05.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-5

WELL DESIGNATION	:	299-W23-5
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,200 W 75,550 [200W-06May91]
LAMBERT COORDINATES	:	N 440,308 E 2,219,685 [HANCONV]
		N 134,190.35m E 566,871.01m [NAD83-06May91]
DATE DRILLED	:	Oct69
DEPTH DRILLED (GS)	:	250-ft
MEASURED DEPTH (GS)	:	~203-ft, 05Mar90
DEPTH TO WATER (GS)	:	186-ft, Oct69; DRY, 22Jan92
CASING DIAMETER	:	4-in carbon steel, +0.48~175-ft; 6-in carbon steel, ~0~250-ft
ELEV TOP CASING	:	664.16-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	663.68-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	6-in casing, 170~245-ft
SCREENED INTERVAL	:	205~238-ft?, 6-in telescoping
COMMENTS	:	FIELD INSPECTION, 09Feb90, 4-in carbon steel casing. 2-ft pad, no posts, capped and locked. Identification stamped on brass marker in pad. In underground radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	05Mar90 - 4-in liner to 170.2-ft. Screen @ 183-ft.
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Removed from water level measurement schedule; Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Rodda
Drilling Company: Not documented
Date Started: 060ct69

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 210ct69

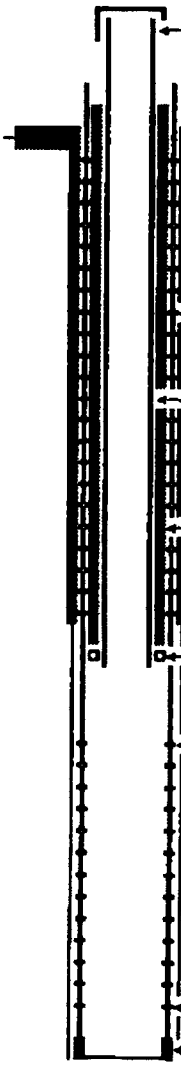
WELL NUMBER: 299-W23-6
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,008 E/W W 75,550
State NAD83 N 134,131.95m E 566,871.04m
Coordinates: N 440,116 E 2,219,685
Start Card #: Not documented T R S
Elevation Ground surface (ft): 665.0 Estimated

Depth to water: 196-ft Oct69
(Ground surface) 205.8-ft 26Mar93

GENERALIZED STRATIGRAPHY — Driller's Log

0-43: SAND and SILT
43-55: SAND
55-63: SAND and CLAY
63-90: Sandy CLAY
90-125: SAND and SILT
125-165: CLAY and SAND
165-250: SAND and GRAVEL

REMEDIATION: Jul80, by Bultena
Perforated 6-in casing 0-160-ft
Set 4-in casing with packer at 165-ft. Grouted with 168-gals grout.



Elevation of reference point (top of casing): [666.98-ft]
Height of reference point above ground surface: [2.0-ft]
Depth of surface seal: [0-160-ft]
Type of surface seal: Grout between 4 & 6-in (perforated) casing
I.D. of surface casing (If present): [ND]
Perforated during remediation 0-160-ft, 2 cuts/rd/ft
I.D. of riser pipe: [4 & 6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Cement grout
Packer set: [165-ft]
Depth top of orig perforations: [172-ft]
Description of perforations:
172-215-ft, not documented
215-248-ft, 2 cuts/rd
Depth bottom of perforations: [248-ft]
Depth bottom of casing: [250-ft]
Depth bottom of borehole: [250-ft]

Drawing By: RKL/2W23-06.ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-37

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-6

WELL DESIGNATION	:	299-W23-6
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,008 W 75,550 [200W-06May91]
LAMBERT COORDINATES	:	N 440,116 E 2,219,685 [HANCONV]
		N 134,131.95m E 566,871.04m [NAD83-06May91]
DATE DRILLED	:	Oct69
DEPTH DRILLED (GS)	:	250-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196-ft, Oct69;
		205.8-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +2.0~165-ft;
		6-in carbon steel, -0.0~250-ft
ELEV TOP CASING	:	666.98-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	665.0-ft, Estimated
PERFORATED INTERVAL	:	6-in casing, 0~160 and 172~248-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 08Feb90,
		4 and 6-in carbon steel casing. Capped, not locked
		No pad, posts or permanent identification.
		Not in radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 19Jun89~26Mar93;
		Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Rodda
Drilling Company: Not documented
Date Started: 22Oct69

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 11Nov69

WELL NUMBER: 299-W23-7
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,699 E/W W 75,550
State NAD83 N 134,342.65m E 566,870.63m
Coordinates: N 440,807 E 2,219,684
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 663.14 Brass cap

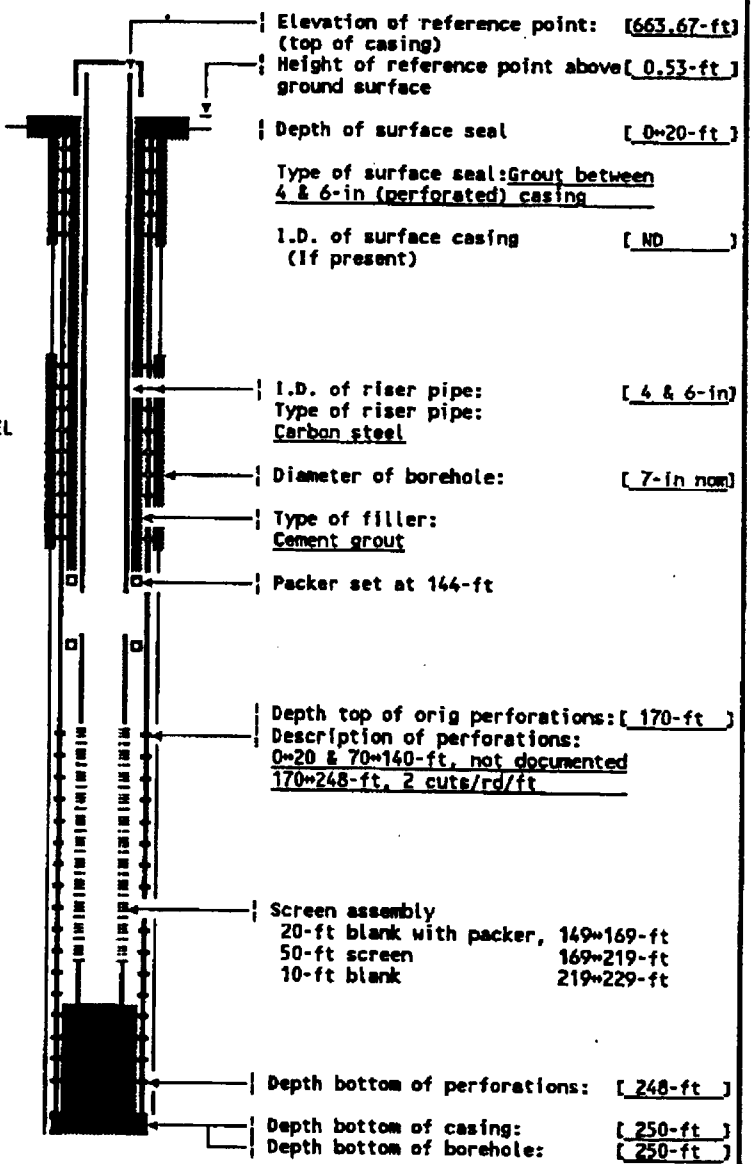
Depth to water: 196 ft Oct69
(Ground surface) 202.5-ft 26Mar93

GENERALIZED STRATIGRAPHY / Driller's Log

0-45: SAND and SILT
45-60: SAND and GRAVEL
60-73: Coarse SAND and SILT
73-120: SAND and SILT
120-155: SANDY CLAY
155-160: SAND, GRAVEL and CLAY
160-175: Coarse SAND and CLAY
175-180: Coarse SAND and GRAVEL
180-190: Coarse SAND, GRAVEL and SILT
190-225: SAND and GRAVEL
225-230: SAND and GRAVEL (Mostly SAND and SILT)
230-235: SAND and SILT
235-240: SAND and SILT, a little GRAVEL
240-250: SAND and GRAVEL

REMEDIATION: Mar76, by Hatch
Perforated 6-in casing 0-140-ft
Set 4-in casing with packer at 144-ft and grouted.

Aug70 by Hatch
Installed screen, screen would not go past 229-ft.
Set plug @ 229-ft.



Drawing By: RKL/2W23-07.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-7

WELL DESIGNATION	:	299-W23-7
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,699 W 75,550 [200W-06May91]
LAMBERT COORDINATES	:	N 440,807 E 2,219,684 [HANCONV]
		N 134,342.65m E 566,870.63m [NAD83-06May91]
DATE DRILLED	:	Nov69
DEPTH DRILLED (GS)	:	250-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196-ft, Oct69;
		202.5-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +0.53~144-ft;
		6-in carbon steel, ~0~250-ft
ELEV TOP CASING	:	663.67-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	663.14-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	6-in casing, 0~20, 70~140 and 170~248-ft
SCREENED INTERVAL	:	169~219-ft, 6-in telescoping
COMMENTS	:	FIELD INSPECTION, 09Feb90,
		4-in carbon steel casing.
		2-ft pad, no posts, capped and locked.
		Identification stamped on brass marker in pad.
		In underground radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	05Mar90 - 4-in liner to 139.7-ft;
		Screen ~161-ft. Dry @ ~197-ft.
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 15Jul74~26Mar93;
		WHC Monthly water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Evans
Drilling Company: Not documented
Date Started: 14Aug72

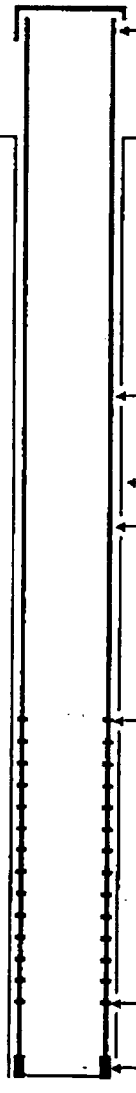
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 05Sep72

WELL NUMBER: 299-W23-8
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,521 E/W W 76,087
State NAD83 N 134,287.75m E 566,707.13m
Coordinates: N 440,627 E 2,219,147
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 661.0 Estimated

Depth to water: 189-ft Sep72
(Ground surface) 199.7-ft 26Mar93

GENERALIZED STRATIGRAPHY / Driller's Log

0-10: SAND with GRAVEL & SILT
10-25: GRAVEL & SAND
25-37: GRAVEL & SAND with SILT
37-84: SAND & SILT
84-92: SAND & GRAVEL
92-105: COBBLES, GRAVEL & SAND
105-130: SAND & SILT
130-153: SILT & SAND
153-180: COBBLES, SAND & SILT
180-190: COBBLES, GRAVEL & SAND
190-235: SAND & GRAVEL



Elevation of reference point (top of casing): [663.95-ft]
Height of reference point above ground surface: [3.0-ft]
Depth of surface seal: [ND]
Type of surface seal: None documented
I.D. of surface casing (If present): [ND]
I.D. of riser pipe: [6-in]
Type of riser pipe: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Depth top of perforations: [165-ft]
Description of perforations:
165-175 ft, 3 cuts/ft
175-185 ft, 6 cuts/ft
185-200 ft, 1 cut/ft
200-205 ft, 3 cuts/ft
205-215 ft, 1 cut/ft
215-230 ft, 3 cuts/ft
Depth bottom of perforations: [230-ft]
Depth bottom of casing: [235-ft]
Depth bottom of borehole: [235-ft]

Drawing By: RKL/2W23-08.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-8

WELL DESIGNATION	:	299-W23-8
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,521 W 76,087 [200W-06May91]
LAMBERT COORDINATES	:	N 440,627 E 2,219,147 [HANCONV]
		N 134,287.75m E 566,707.13m [NAD83-06May91]
DATE DRILLED	:	Sep72
DEPTH DRILLED (GS)	:	235-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	189-ft, Sep72;
		199.7-ft, 20Apr93
CASING DIAMETER	:	6-in carbon steel, +3.0-235-ft;
ELEV TOP CASING	:	663.95-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	661.0-ft, Estimated
PERFORATED INTERVAL	:	6-in casing, 165-230-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 08Feb90,
		6-in carbon steel casing. Capped, not locked
		No pad, posts or permanent identification.
		Not in radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 13Dec89-26Mar93;
		Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Evans
Drilling Company: Not documented
Date Started: 14Jul72

Sample Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 10Aug72

WELL NUMBER: 299-W23-9
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,480 E/W W 76,300
State Coordinates: N 440,586 E 2,218,934
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 661.3 Estimated

Depth to water: 188.8-ft Aug72
(Ground surface) 198.7-ft Mar92

GENERALIZED STRATIGRAPHY / Driller's Log

0-6: Fine-coarse SAND
6-10: SILT w/fine SAND
10-29: Coarse SAND-4-in GRAVEL
29-31: SILT w/some GRAVEL
31-38: SAND-4-in GRAVEL
38-60: Fine SAND and SILT
60-80: SILT and SAND
80-89: Coarse-fine SAND
89-91: SAND & SILT
91-100: SAND w/5-in GRAVEL
100-112: SAND and SILT w/COBBLES
112-144: SAND & SILT
144-156: SILT w/some SAND
156-160: SILT & SAND & 4½-in GRAVEL
160-161: Coarse-fine SAND
160-172: SAND and some 3-5-in GRAVEL
172-180: SAND and 2-in GRAVEL
180-182: SAND
182-196: SAND and GRAVEL
196-200: GRAVEL
200-212: Coarse-fine SAND & 1-in GRAVEL
212-222: Coarse-fine SAND w/½-in GRAVEL
222-230: Coarse SAND w/some GRAVEL
230-235: Coarse-fine SAND

REMEDIATION:
May83 by Garcia(?)
Cut 6-in casing to ground level.
Cleaned well and peforated 0-20 and 50-95-ft.
Ran 5-in casing to 102-ft. Spot cemented. Grouted annulus between 5 and 6-in casing with 108-gal cement total.

Elevation of reference point: [664.50-ft] (top of casing)
Height of reference point above ground surface [3.2-ft]
Depth of surface seal [0-20-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
I.D. of riser pipes: [5 & 6-in]
Type of riser pipes: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
6-in casing annular seal perforations
Description of perforations: 0-20 and 50-95-ft, not documented
5-in liner set to 102-ft on packer. Sand placed above packer.
Depth top of original perforations: [164-ft]
164-190-ft, 6 cuts/rd/ft
190-200-ft, 3 cuts/rd/ft
200-230-ft, 6 cuts/rd/ft
Depth bottom of perforations: [230-ft]
Depth bottom of casing: [235-ft]
Depth bottom of borehole: [235-ft]

Drawing By: RKL/2W23-09.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-9

WELL DESIGNATION	:	2-W23-9
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,480 W 76,300
LAMBERT COORDINATES	:	N 440,586 E 2,218,934 [HANCONV]
DATE DRILLED	:	Aug72
DEPTH DRILLED (GS)	:	235-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	188.8-ft, Aug72; 198.7-ft, 11Mar92
CASING DIAMETER	:	6-in, 0-235-ft; 5-in liner, +3.2-102-ft
ELEV TOP CASING	:	664.50-ft
ELEV GROUND SURFACE	:	661.3-ft, Estimated
PERFORATED INTERVAL	:	0-20 and 50-95-ft; 164-230-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 11Mar92, 5-in carbon steel casing. 2-ft cement pad. No posts, capped and locked. Identification stamped on brass cap in pad. Not in radiation zone. OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured, 06Apr90-25Nov91; PNL Annual; WHC Monthly and Semiannual water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Evans
Drilling Company: Not documented
Date Started: 08Sep72

Sample Method: Drive barrel
Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 040ct72

WELL NUMBER: 299-W23-10
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,420 E/W W 76,535
State Coordinates: N 440,525 E 2,218,699
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: 190.0-ft Oct72
(Ground surface) 202-ft Jan92

GENERALIZED STRATIGRAPHY — Driller's Log

0-5: SAND
5-30: SAND, SILT and GRAVEL
30-34: SAND, COBBLES and GRAVEL
34-45: SAND and GRAVEL
45-55: SAND and GRAVEL, w/some SILT
55-60: SAND w/some GRAVEL
60-65: SAND w/some SILT
65-83: SAND
83-96: Silty SAND
96-105: SAND and GRAVEL w/some SILT
105-110: Sandy SILT
110-120: Silty SAND
120-143: SILT w/some SAND
143-155: SILT w/some SAND and GRAVEL
155-165: SAND w/GRAVEL
165-170: SAND and GRAVEL w/some SILT
170-179: SAND and GRAVEL/COBBLES
179-185: Not documented
185-193: SAND w/some GRAVEL and SILT
193-195: SAND w/some GRAVEL/COBBLES
195-215: SAND and GRAVEL w/some SILT
215-229: SAND and GRAVEL
229-235: SAND w/some GRAVEL

REMEDIATION:
May83 by Garcia(?)
Cleaned well and perforated 0-20 and 50-95-ft.
Ran 5-in casing to 105-ft.
Grouted annulus between 5-6-in casing. Some cement went past packer.
108-gal cement total.

Elevation of reference point: [664.77-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-20-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
I.D. of riser pipes: [5 & 6-in]
Type of riser pipes: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
6-in casing annular seal perforations
Description of perforations: 0-20 and 50-95-ft, 2 cuts/rd/ft
5-in liner set to 105-ft on packer. Sand placed above packer.
Depth top of original perforations: [165-ft]
165-178-ft, 2 cuts/rd/ft
186-230-ft, Not documented
Depth bottom of perforations: [230-ft]
Depth bottom of casing: [235-ft]
Depth bottom of borehole: [235-ft]

Drawing By: RKL/2W23-10.ASB Date: 20Apr93
Reference: HANFORD WELLS

APP D-45

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-10

WELL DESIGNATION	:	299-W23-10
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,420 W 76,535
LAMBERT COORDINATES	:	N 440,525 E 2,218,699 [HANCONV]
DATE DRILLED	:	Oct72
DEPTH DRILLED (GS)	:	235-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	190.0-ft, Oct72;
(TOC)	:	202.4-ft, 14Jan92
CASING DIAMETER	:	6-in carbon steel, ~0~235-ft;
		5-in carbon steel, +ND~105-ft
ELEV TOP CASING	:	664.77-ft
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	0~20 and 50~95-ft;
		165~230-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Water levels measured, 05Apr90~14Jan92;
		PNL Annual and Semiannual, WHC Quarterly water sample schedule
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Evans
Drilling Company: Not documented
Date Started: 10Oct72
Date Complete: 07Nov72

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented

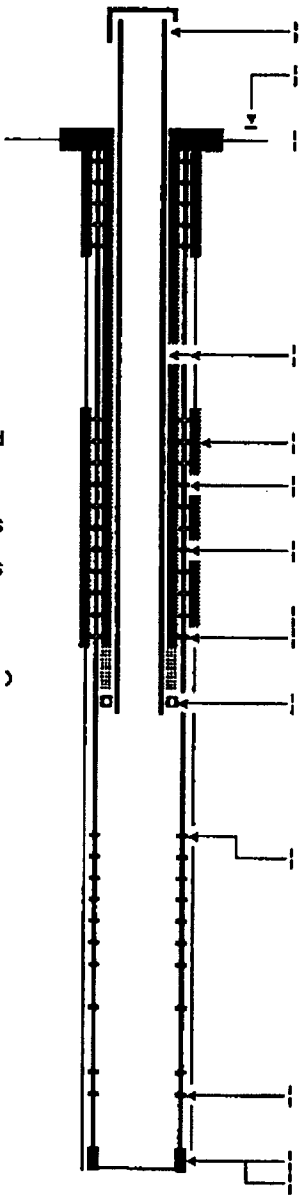
WELL NUMBER: 299-W23-11
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,560 E/W W 76,725
State Coordinates: N 440,665 E 2,218,509
Start Card #: Not documented T R S
Elevation Ground surface (ft): Not documented

Depth to water: 187.0-ft Nov72
(Ground surface) 201-ft 08Dec93

GENERALIZED STRATIGRAPHY — Driller's Log

0-3: SAND
3-11: SAND and COBBLES
11-24: SAND, GRAVEL and COBBLES
24-43: SAND and GRAVEL
43-50: Silty SAND
50-90: SAND and SILT
90-100: SAND and GRAVEL/COBBLES
100-105: SAND and GRAVEL
105-106: SILT
106-135: SAND and SILT
135-155: Sandy SILT
155-160: SAND
160-165: SAND w/some SILT and CLAY and GRAVEL, tightly packed
165-194: As above, no CLAY
194-200: SAND and SILT and GRAVEL/COBBLES
200-212: SAND w/some GRAVEL/COBBLES and SILT
193-195: SAND w/some GRAVEL/COBBLES
212-225: SAND and SILT
(Had gas detonation from spark going down hole. Measured as 1,000 ppm after well was closed in.)
225-235: SAND and SILT

REMEDIATION:
May83 by Troy (?)
Cleaned well and perforated 0-20 and 50-95-ft.
Ran 5-in casing to 105-ft.
Grouted annulus between 5-6-in casing.



Elevation of reference point: [664.14-ft] (top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [0-20-ft]
Type of surface seal: Cement grout through perforations
I.D. of surface casing (If present) [ND]
I.D. of riser pipes: [5 & 6-in]
Type of riser pipes: Carbon steel
Diameter of borehole: [7-in nom]
Type of filler: Not documented
Elevation/depth top of seal
Type of seal: Not documented
6-in casing annular seal perforations
Description of perforations: 0-20 and 50-95-ft, 2 cuts/rd/ft
5-in liner set to 105-ft on packer. Sand placed above packer.
Depth top of original perforations: [165-ft]
Description of perforations:
165-180-ft, 1 cut/rd/ft
180-198-ft, 2 cuts/rd/ft
205-207-ft, 2 cuts/rd/ft
225-230-ft, 2 cuts/rd/ft
Depth bottom of perforations: [230-ft]
Depth bottom of casing: [235-ft]
Depth bottom of borehole: [235-ft]

Drawing By: RKL/2W23-11.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-11

WELL DESIGNATION	:	299-W23-11
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,560 W 76,725
LAMBERT COORDINATES	:	N 440,665 E 2,218,509 [HANCONV]
DATE DRILLED	:	Nov72
DEPTH DRILLED (GS)	:	235-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	187.0-ft, Nov72;
(TOC)	:	201.7-ft, 08Dec92
CASING DIAMETER	:	6-in carbon steel, ~0~235-ft;
		5-in carbon steel, +ND~105-ft
ELEV TOP CASING	:	664.14-ft
ELEV GROUND SURFACE	:	Not documented
PERFORATED INTERVAL	:	0~20 and 50~95-ft;
		165~198, 205~207, and 225~230-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	Separations area water level measurement, 01Jun78~08Dec92;
		PNL Annual, WHC Quarterly water sample schedule
PUMP TYPE	:	Electric submersible
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Rodda
Drilling Company: Not documented
Date Started: 04Sep70

Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: 020ct70

WELL NUMBER: 299-W23-12
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,969 E/W W 75,625
State Coordinates: N 441,077 E 2,219,608
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 665.64 Brass cap

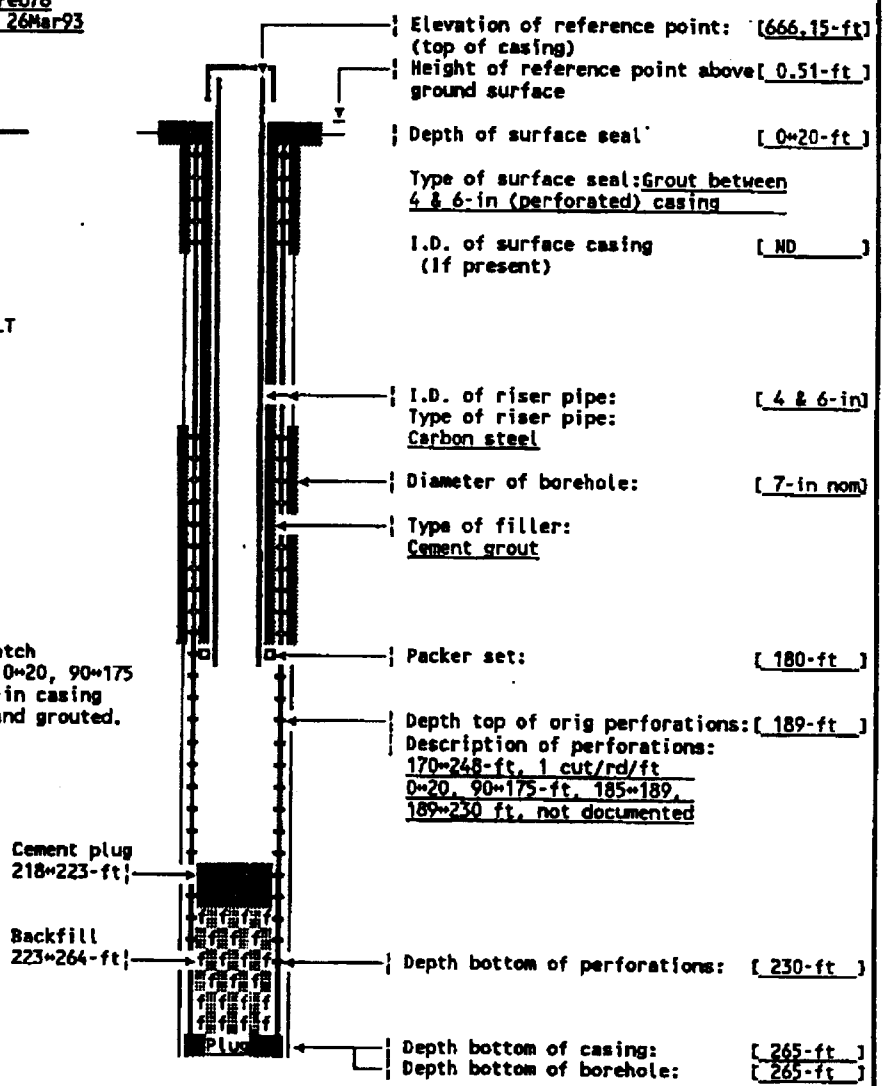
Depth to water: 191-ft Feb76
(Ground surface) 204.5-ft 26Mar93

GENERALIZED STRATIGRAPHY — Driller's Log

0-50: SAND and GRAVEL
50-52: SAND and GRAVEL, (Solid substance)
52-70: SAND and SILT
70-93: Fine SAND and SILT
93-142: SAND and SILT
142-175: Sandy CLAY
175-233: SAND and GRAVEL
233-263: Fine SAND and SILT
263-265: CLAY and GRAVEL

REMEDIATION: Feb76, by Hatch
Perforated 6-in casing 0-20, 90-175 and 185-189 ft. Set 4-in casing with packer to 180-ft and grouted.

Backfilled 223-232-ft.
Cement plug 218-223-ft



Plug 264-265-ft

Drawing By: RKL/2W23-12.ASB Date: 20Apr93
Reference: HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-12

WELL DESIGNATION	:	299-W23-12
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Not applicable
HANFORD COORDINATES	:	N 35,969 W 75,625 [200W-06May91]
LAMBERT COORDINATES	:	N 441,077 E 2,219,606 [HANCONV]
		N 134,424.74m E 566,847.55m [NAD83-06May91]
DATE DRILLED	:	Oct70
DEPTH DRILLED (GS)	:	265-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	191-ft, Feb76;
	:	204.5-ft, 26Mar93
CASING DIAMETER	:	4-in carbon steel, +0.51-180-ft;
		6-in carbon steel, ~0-265-ft
ELEV TOP CASING	:	666.15-ft, [NGVD'29-06May91]
ELEV GROUND SURFACE	:	665.64-ft, Brass cap [NGVD'29-06May91]
PERFORATED INTERVAL	:	6-in casing, 0-20, 90-175, and 185-230-ft
SCREENED INTERVAL	:	Not applicable
COMMENTS	:	FIELD INSPECTION, 09Feb90,
		4-in carbon steel casing.
		2-ft pad, no posts, capped and locked.
		No permanent identification.
		In underground radiation zone.
		OTHER:
AVAILABLE LOGS	:	Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 25Jul91-26Mar93;
		Not on water sample schedule
PUMP TYPE	:	None documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: D Ludtke/B Strode
M Wrasper/M Thorensen
Drilling Company: Kaiser Engineers
Date Started: 21Feb91
Date Complete: 28Feb91

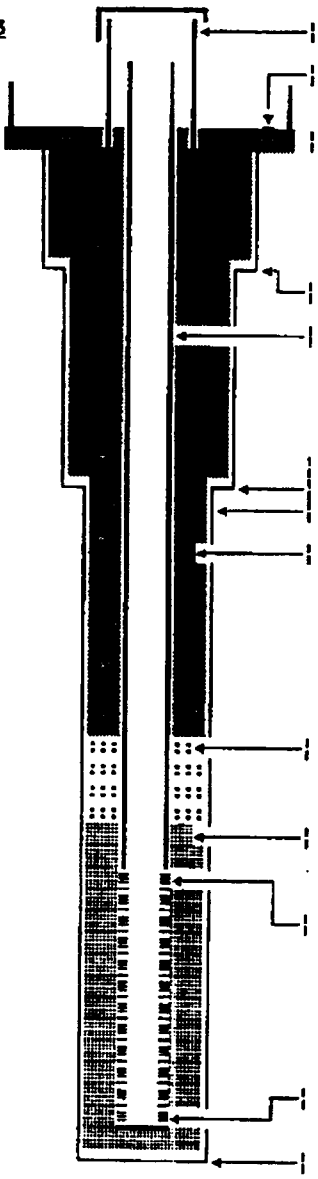
Sample Method: Drive barrel
Hard tool
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford

WELL NUMBER: 299-W22-39
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 35,276 E/W W 75,442
State NAD83 134,213.67m 566,903.88m
Coordinates: N 440,384 E 2,219,793
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 665.26 Brass cap

Depth to water: 202.5-ft Feb91
(Ground surface) 206.2-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: SAND
5-10: Gravelly SAND
10-24: SAND
24-24.5: Sandy SILT
24.5-55: SAND
55-60: Silty sandy GRAVEL
60-65: SAND
65-70: Sl gravelly SAND
70-127: SAND
127-127.5: SILT lens
127.5-129: SAND
130-138: Silty SAND
138-145: Sl silty SAND
145-147: Sandy SILT
147-148: Silty sandy GRAVEL
trace CALICHE
148-155: Silty SAND
155-160: Gravelly sandy SILT
160-165: Sl gravelly sandy SILT
165-175: Silty SAND
175-195: Gravelly silty SAND
195-205: Sl silty gravelly SAND
205-210: Sl silty SAND
210-220: Sl silty sandy GRAVEL
220-223.3: Sandy GRAVEL



Elevation of reference point: [668.26-ft]
(top of casing)
Height of reference point above ground surface [3.00-ft]
Depth of surface seal [0-19.0-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad to 2.0-ft
4 equidistant protective posts
Cement grout, 2.0-20.0-ft
13-in nominal hole to 20.2-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
20.2-146.8-ft, 11-in nominal
146.8-223.3-ft, 9-in nominal
Type of filler, 20.0-192.6-ft
8-20 mesh bentonite crumbles
Depth top of seal: [192.6-ft]
Type of seal:
Bentonite 1/4-in pellets
Depth top of sand pack: [196.3-ft]
20-40-mesh silica sand
Depth top of screen: [199.8-ft]
4-in, #10-slot, stainless steel
with channel pack
Depth bottom of screen [221.3-ft]
Depth to bottom of borehole: [223.3-ft]

Drawing By: RKL/2W22-39.ASB Date: 20Apr93
Reference: WHC-SD-EN-DP-041

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-39

WELL DESIGNATION	:	299-W22-39
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 35,276 W 75,442 [200W-01Apr91]
LAMBERT COORDINATES	:	N 440,384 E 2,219,793 [HANCONV]
	:	N 134,213.67m E 566,903.88m [NAD83-01Apr91]
DATE DRILLED	:	Feb91
DEPTH DRILLED (GS)	:	223.3-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	202.5-ft, 13Feb91; 206.2-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +0.9~199.8-ft; 6-in stainless steel, +3.0~0.5-ft
ELEV TOP CASING	:	668.26-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	665.26-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	199.8~221.3-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist, driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 01Jul91~26Mar93, RCRA WMA S-SX Quarterly water sample schedule
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid-Used: 200 W Water Supply
Driller's Name: M Wraspir D Ludtke/J Moomaw
Drilling Company: Kaiser Engineers
Date Started: 11Oct91

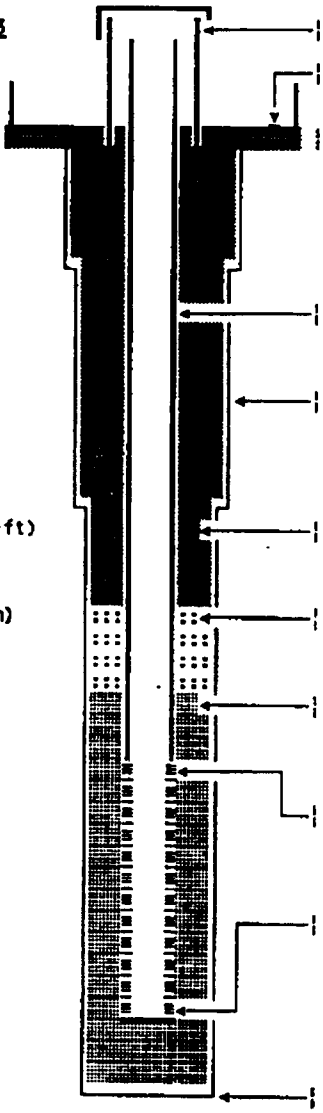
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 26Nov91

WELL NUMBER: 299-W22-44 TEMPORARY WELL NO:
Hanford Coordinates: N/S N 36,163.9 E/W W 75,268.6
State NAD83 N 134,484.42m E 566,955.99m
Coordinates: N 441,272 E 2,219,964
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 674.77 (Brass cap)

Depth to water: 210.5-ft Nov91
(Ground surface) 213.6-ft 26Mar93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-5: Sl gravelly SAND
5-10: SAND
10-15: Sl silty-sl gravelly SAND
15-20: Sl silty SAND
20-30: SAND
30-35: Sl silty SAND
35-40: Silty SAND
40-45: Silty sandy GRAVEL
45-60: Sandy GRAVEL
60-65: Sl gravelly SAND
65-98: SAND
98-99: Sandy SILT
99-115: SAND
115-135: Sl silty SAND
135-140: SAND
140-145: Sl silty SAND
145-155: SAND
(Sandy SILT @ 150.5-151-ft)
155-165: Sl gravelly SAND
165-180: SAND
180-190: Silty SAND
190-215: Sandy GRAVEL (Ringold Fm)
215-246: Silty sandy GRAVEL



Elevation of reference point: [678.13-ft] (top of casing)
Height of reference point above ground surface [3.36-ft]
Depth of surface seal [0.0-19.7-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 2.0-19.7-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
0-19.2-ft, 13-in nominal
19.2-151.6-ft, 11-in nominal
151.6-246.0-ft, 9-in nominal
Type of filler, 19.7-196.0-ft
Bentonite crumbles
Depth top of seal: [196.0-ft]
Type of seal:
Bentonite pellets
Depth top of sand pack: [200.5-ft]
10-20-mesh silica sand
Depth top of screen: [205.1-ft]
4-in, #20-slot, continous wrap
T304 stainless steel with
filter pack
Depth bottom of screen: [242.2-ft]
Depth to bottom of borehole: [246.0-ft]

Drawing By: RKL/2W22-44.ASB Date: 20Apr93
Reference:

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-44

WELL DESIGNATION	:	299-W22-44
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, S/SX Farm
HANFORD COORDINATES	:	N 36,163.9 W 75,268.6 [200W-20May92]
LAMBERT COORDINATES	:	N 441,272 E 2,219,964 [HANCONV]
		N 134,484.42m E 566,955.99m [NAD83-20May92]
DATE DRILLED	:	Nov91
DEPTH DRILLED (GS)	:	246.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	210.5-ft, Nov91; 213.6-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.0~205.1-ft; 6-in stainless steel, +3.36~0.5-ft
ELEV TOP CASING	:	678.13-ft, [NGVD'29-20May92]
ELEV GROUND SURFACE	:	674.77-ft, Brass cap [NGVD'29-20May92]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	205.1~242.2-ft, 4-in #20-slot stainless steel;
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 24Jan92~26Mar93; Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake at 232.4-ft (TOC)
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

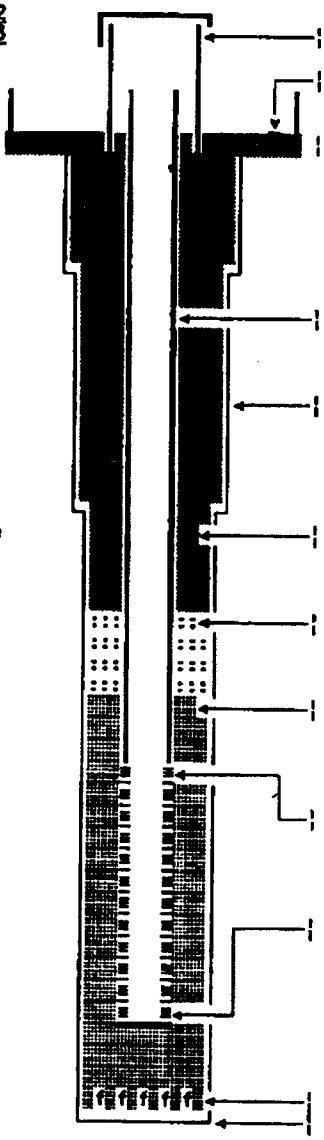
Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: K. Olson
Drilling Company: Kaiser Engineers
Date Started: 15Jul92
Sample Method: Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Drilling Company Location: Hanford
Date Complete: 04Sep92

WELL NUMBER: 299-W22-45
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 35,534.6 E/W W 75,305.5
State NAD83 N 134,292.51m E 566,945.16m
Coordinates: N 440,643 E 2,219,928
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 662.97 (Brass cap)

Depth to water: 201.3-ft 21Aug92
(Ground surface) 203.4-ft 20May93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: Sandy GRAVEL
5-15: Sl gravelly SAND
15-17: SAND
17-18.5: SILT
18.5-35: Silty SAND
35-39: Sandy GRAVEL
39-40: Sl gravelly SAND
40-45: SAND
45-50: Gravelly SAND
50-55: SAND
55-65: Sl silty SAND
65-105: Silty SAND
105-112: Sl silty SAND
112-114: Silty SAND
114-117: SAND
117-117.5: SILT
117.5-145.5: Silty SAND
HANFORD-Fine/Early Palouse
PLIO-PLEISTOCENE contact @ 145.5-ft
145.5-147: Clayey sandy GRAVEL w/CALICHE
RINGOLD contact @ 147-ft
147-155: Gravelly SAND
155-160: Sand w/PEBBLES and SILT
160-165: Sl gravelly SAND w/SILT
165-170: SAND w/SILT
170-175: Silty sandy GRAVEL (paleosol @ 174-ft)
175-180: Sandy GRAVEL
180-185: Silty sandy GRAVEL
185-195: Sandy GRAVEL w/SILT
195-210: Gravelly SAND w/SILT
210-220: Sandy GRAVERL w/SILT
220-223: SAND w/SILT
223-240: Silty SANDY gravel



Elevation of reference point: [666.21-ft] (top of casing)
Height of reference point above ground surface [3.24-ft]
Depth of surface seal [0.0-8.1-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad 4 equidistant protective posts Cement grout 0.0-8.1-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole, 0-19.2-ft, 13-in nominal 19.2-147.3-ft, 11-in nominal 147.3-240.0-ft, 9-in nominal
Type of filler, 8.1-190.4-ft 8-20-mesh bentonite crumbles
Depth top of seal: [190.4-ft]
Type of seal: 3/8-in bentonite pellets
Depth top of sand pack: [193.6-ft]
10-20-mesh silica sand
Depth top of screen: [198.1-ft]
4-in, #20-slot, continous wrap T304 stainless steel with filter pack
Depth bottom of screen: [233.9-ft]
Fill, 239.0-240.0-ft
Depth to bottom of borehole: [240.0-ft]

Drawing By: RKL/2W22-45.ASB Date: 28Jun93
Reference: WHC-SD-EN-DP-042

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-45

WELL DESIGNATION	:	299-W22-45
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, S-SX Farm
HANFORD COORDINATES	:	N 35,534.6 W 75,305.5 [200W-29Sep92]
LAMBERT COORDINATES	:	N 440,643 E 2,219,928 [HANCONV]
		N 134,292.51m E 566,945.16m [NAD83-29Sep92]
DATE DRILLED	:	Sep92
DEPTH DRILLED (GS)	:	240.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	201.3-ft, 21Aug92
		203.4-ft, 20May93
CASING DIAMETER	:	4-in stainless steel, +1.6~198.1-ft;
		6-in stainless steel, +3.24~0.5-ft
ELEV TOP CASING	:	666.21-ft, [NGVD'29-29Sep92]
ELEV GROUND SURFACE	:	662.97-ft, Brass cap [NGVD'29-29Sep92]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	198.1~233.9-ft, 4-in #10-slot stainless steel;
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurements;
		Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake not documented
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: N Wraspir
Drilling Company: Kaiser Engineers
Date Started: 24Sep91

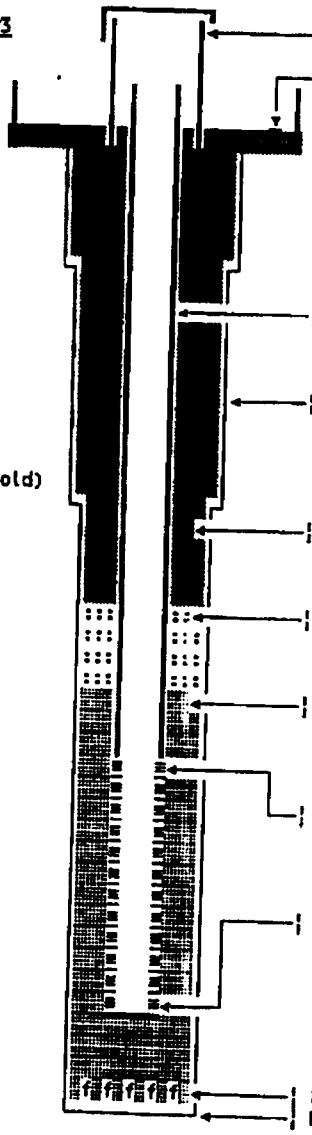
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 12Nov91

WELL NUMBER: 299-W22-46
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 34,994.2 E/W W 75,442.6
State NAD83 N 134,127.84m E 566,903.85m
Coordinates: N 440,102 E 2,219,793
Start Card #: Not documented. T___ R___ S___
Elevation Ground surface (ft): 667.60 (Brass cap)

Depth to water: 205.9-ft Nov91
(Ground surface) 208.6-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: Not documented
5-25: SAND
25-30: Silty SAND
30-35: SAND
35-40: Silty SAND
40-45: SAND
45-55: Silty SAND
55-60: Sl silty gravelly SAND
60-70: Sandy GRAVEL
70-85: Sl silty SAND
85-95: Silty SAND
95-100: Sl silty SAND
100-110: Silty SAND
110-135: Sl silty SAND
135-140: Silty SAND
140-165: Silty sandy GRAVEL (Ringold)
165-170: Silty SAND
170-225: Silty sandy GRAVEL
225-230: Silty gravelly SAND
230-235: Sl gravelly silty SAND
235-241: Silty sandy GRAVEL



Elevation of reference point: [671.18-ft] (top of casing)
Height of reference point above ground surface [3.58-ft]
Depth of surface seal [2.0-21.2-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 2.0-21.2-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole,
0-20.1-ft, 13-in nominal
20.1-139.2-ft, 11-in nominal
139.2-241.0-ft, 9-in nominal
Type of filler, 21.2-186.1-ft
Bentonite crumbles
Depth top of seal: [186.1-ft]
Type of seal:
3/8-in bentonite pellets
Depth top of sand pack: [188.3-ft]
20-40-mesh silica sand
Depth top of screen: [192.9-ft]
4-in, #10-slot, continous wrap T304 stainless steel with filter pack
Depth bottom of screen: [228.9-ft]
Fill, 238.7-241.0-ft
Depth to bottom of borehole: [241.0-ft]

Drawing By: RKL/2W22-46.ASB Date: 20Apr93
Reference:

APP D-57

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W22-46

WELL DESIGNATION	:	299-W22-46
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, S Farm
HANFORD COORDINATES	:	N 34,994.2 W 75,442.6 [200W-13Dec91]
LAMBERT COORDINATES	:	N 440,102 E 2,219,793 [HANCONV]
		N 134,127.84m E 566,903.85m [NAD83-13Dec91]
DATE DRILLED	:	Nov91
DEPTH DRILLED (GS)	:	241.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	205.9-ft, Nov91;
		208.8-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +0.5~192.9-ft;
		6-in stainless steel, +3.58~0.5-ft
ELEV TOP CASING	:	671.18-ft, [NGVD'29-13Dec91]
ELEV GROUND SURFACE	:	667.60-ft, Brass cap [NGVD'29-13Dec91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	192.9~228.9-ft, 4-in #10-slot stainless steel;
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 23Jan92~26Mar93;
		Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake at 227.6-ft (TOC)
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: R Jones/L Watkins
G Thomas/B Strode
Drilling Company: Kaiser Engineers
Date Started: 17Oct90

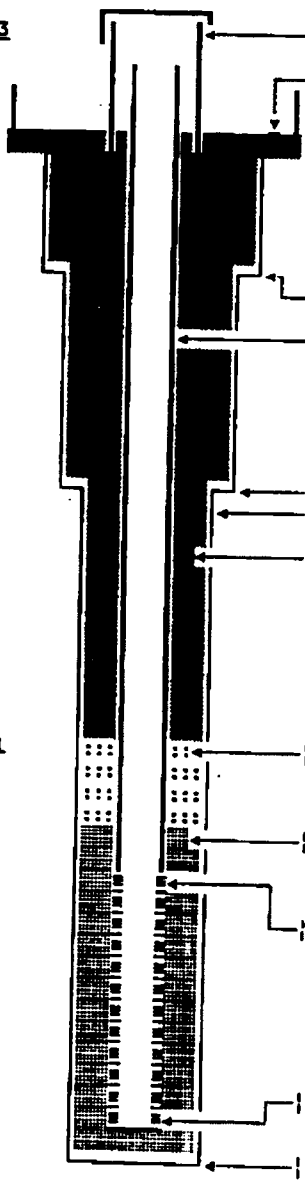
Sample Method: Drive barrel
Hard tool
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 04Dec90

WELL NUMBER: 299-W23-13
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 36,040
State NAD83 134,445.93m
Coordinates: N 441,147
E/W W 76,067
566,712.80m
E 2,219,166
Start Card #: Not documented
T ___ R ___ S ___
Elevation Ground surface (ft): 663.34 Brass cap

Depth to water: 197.9-ft Nov90
(Ground surface) 201.5-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: (Not documented)
5-10: Sl silty SAND
10-15: Gravelly SAND
15-20: Sl silty SAND
20-40: Sandy GRAVEL
40-45: Sl gravelly SAND
45-71: SAND
71-72: SILT
72-73: Sandy SILT
73-78: SAND
78-82: Sl gravelly silty SAND
82-90: Silty sandy GRAVEL
90-95: Gravelly silty SAND
95-100: Sl gravelly sl silty SAND
100-105: SAND
105-125: Sl silty SAND
125-129.5: Silty SAND
129.5-134: SILT
134-145: Sandy SILT
145-150: Sl silty SAND
150-155: Silty SAND, possible CALICHE @ 153.5-ft
155-165: SAND<>Sandy GRAVEL
165-185: Gravelly sandy MUD
185-200: Gravelly muddy SAND
200-205: Muddy sandy GRAVEL
205-210: Silty sandy GRAVEL
210-217: Clayey/silty sandy GRAVEL
217-217.2: SAND



Elevation of reference point: [666.33-ft] (top of casing)
Height of reference point above ground surface [2.99-ft]
Depth of surface seal [0-19.0-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 2.7-ft
4 equidistant protective posts
Cement grout, 2.7-18.5-ft
13-in nominal hole to 20.0-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole, 20.0-154.5-ft, 11-in nominal
154.5-218.2-ft, 9-in nominal
Type of filler, 18.5-186.6-ft 8-20 mesh bentonite crumbles
Depth top of seal: [186.6-ft]
Type of seal: Bentonite 1/4-in pellets
Depth top of sand pack: [190.4-ft]
8-12-mesh silica sand
Depth top of screen: [195.9-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [217.2-ft]
Depth to bottom of borehole: [218.2-ft]

Drawing By: RKL/2W23-13.ASB Date: 26Mar93
Reference: WHC-SD-EN-DP-041

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-13

WELL DESIGNATION	:	299-W23-13
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 36,040 W 76,067 [200W-01Apr91]
LAMBERT COORDINATES	:	N 441,147 E 2,219,166 [HANCONV]
	:	N 134,445.93m E 566,712.80m [NAD83-01Apr91]
DATE DRILLED	:	Dec90
DEPTH DRILLED (GS)	:	218.2-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	197.9-ft, 30Nov90; 201.5-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.0~195.9-ft; 6-in stainless steel, +3.0~0.5-ft
ELEV TOP CASING	:	666.33-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	663.34-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	195.9~217.2-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist, driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 01Jul91~26Mar93, RCRA WMA S-SX Quarterly water sample schedule
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Raw water
Driller's Name: L Bultena
Drilling Company: Kaiser Engineers
Date Started: 08Jan91

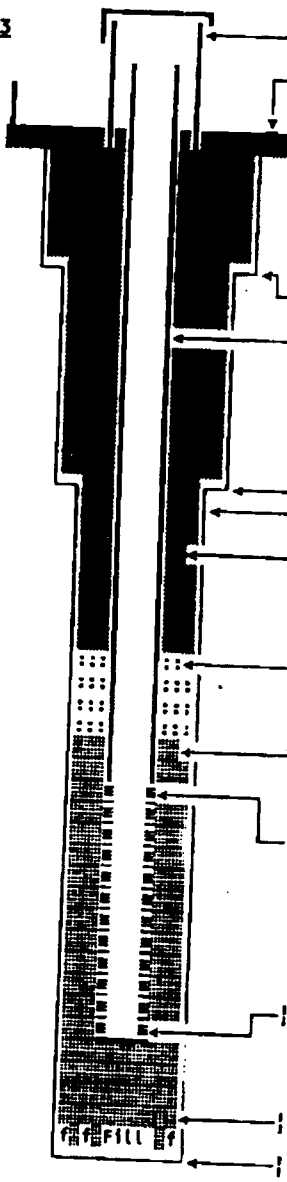
Sample Method: Drive barrel
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 16Apr91

WELL NUMBER: 299-W23-14
TEMPORARY WELL NO: None
Hanford Coordinates: N/S N 35,529 134,290.17m E/W W 76,082 566,708.67m
State NAD83 Coordinates: N 440,636 E 2,219,152
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 661.00 Brass cap

Depth to water: 196.9-ft Jan91
(Ground surface) 199.9-ft 26Mar93

GENERALIZED Geologist's STRATIGRAPHY Log
Sl=slightly

0-5: (Not documented)
5-10: SAND
10-15: Sl gravelly SAND
15-25: SAND
25-30: Sl gravelly SAND
30-35: Sandy GRAVEL
35-40: Silty sandy GRAVEL
40-45: Sl silty SAND
45-50: Silty SAND
50-65: Sl silty SAND
65-75: Silty SAND
75-80: Sl silty SAND
80-85: Silty SAND
85-90: Sl gravelly sl silty SAND
90-99: Sandy GRAVEL
99-105: Sl silty SAND
105-125: Silty SAND
125-135: SILT
135-150: Sandy SILT
150-155: SAND
155-159: Sl silty SAND
159-165: Silty sandy GRAVEL
162-170: SAND
170-180: Sl gravelly SAND
180-195: Sl silty gravelly SAND
195-200: Gravelly silty SAND
200-223.8: Gravelly sandy MUD



Elevation of reference point: [664.00-ft] (top of casing)
Height of reference point above ground surface [3.00-ft]
Depth of surface seal [0-20.4-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 3.0-ft
4 equidistant protective posts
Cement grout, 3.0-20.4-ft
13-in nominal hole to 19.3-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole, 19.3-163.9-ft, 11-in nominal
163.9-224.4-ft, 9-in nominal
Type of filler, 20.4-187.0-ft 8-20 mesh bentonite crumbles
Depth top of seal: [187.0-ft]
Type of seal: Bentonite 1/2-in pellets
Depth top of sand pack: [190.4-ft]
8-12-mesh silica sand
Depth top of screen: [194.0-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [215.3-ft]
Depth bottom of sandpack: [223.7-ft]
Depth to bottom of borehole: [224.4-ft]

Drawing By: RKL/2W23-14.ASB Date: 20Apr93
Reference: WHC-SD-EN-DP-041

APP D-61

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-14

WELL DESIGNATION	:	299-W23-14
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	Single Shell Tanks
HANFORD COORDINATES	:	N 35,529 W 76,082 [200W-01Apr91]
LAMBERT COORDINATES	:	N 440,636 E 2,219,152 [HANCONV]
		N 134,290.17m E 566,708.67m [NAD83-01Apr91]
DATE DRILLED	:	Apr91
DEPTH DRILLED (GS)	:	224.4-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	196.9-ft, 31Jan91; 199.9-ft, 26Mar93
CASING DIAMETER	:	4-in stainless steel, +1.1~194.0-ft; 6-in stainless steel, +3.0~0.5-ft
ELEV TOP CASING	:	664.00-ft, [NGVD'29-01Apr91]
ELEV GROUND SURFACE	:	661.00-ft, Brass cap [NGVD'29-01Apr91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	194.0~215.3-ft, 4-in #10-slot stainless steel, with channel pack
COMMENTS	:	FIELD INSPECTION, OTHER: Geologist, driller
AVAILABLE LOGS	:	Not applicable
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	SST Monthly water level measurement, 01Jul91~26Mar93, RCRA WMA S-SX Quarterly water sample schedule
LISTED USE	:	Hydrostar
PUMP TYPE	:	
MAINTENANCE	:	

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: T Ockert/G Haney
Drilling Company: Kaiser Engineers
Date Started: 17Sep91
Date Complete: 03Dec91

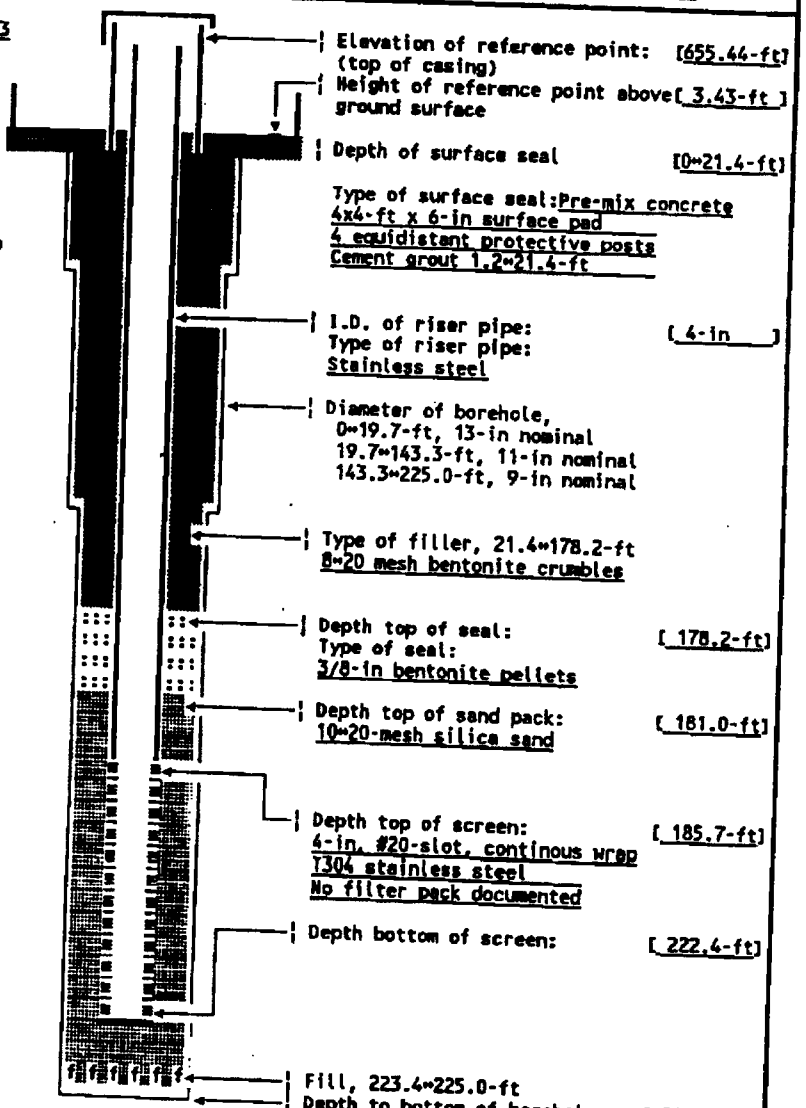
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford

WELL NUMBER: 299-W23-15
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 34,993.1 E/W W 75,803.1
State NAD83 N 134,127.23m E 566,794.00m
Coordinates: N 440,100 E 2,219,432
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 652.01 (Brass cap)

Depth to water: 189.8-ft Nov91
(Ground surface) 192.2-ft 26Mar93

GENERALIZED STRATIGRAPHY Log
Geologist's
Sl=slightly

0-5: SAND
5-10: Sl gravelly SAND
15-60: SAND
60-65: Sl silty SAND
65-80: Sl silty, sl gravelly SAND
80-115: Sl silty SAND
115-130: Silty SAND
130-135: Sandy SILT
135-150: SILT
150-155: Silty sandy GRAVEL
155-175: Sandy GRAVEL
175-220: Silty sandy GRAVEL
220-225: Silty gravelly SAND
225 : Silty sandy GRAVEL



Elevation of reference point: [655.44-ft]
(top of casing)
Height of reference point above ground surface [3.43-ft]
Depth of surface seal [0-21.4-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 1.2-21.4-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
0-19.7-ft, 13-in nominal
19.7-143.3-ft, 11-in nominal
143.3-225.0-ft, 9-in nominal
Type of filler, 21.4-178.2-ft
8-20 mesh bentonite crumbles
Depth top of seal: [178.2-ft]
Type of seal:
3/8-in bentonite pellets
Depth top of sand pack: [181.0-ft]
10-20-mesh silica sand
Depth top of screen: [185.7-ft]
4-in, #20-slot, continous wrap
T304 stainless steel
No filter pack documented
Depth bottom of screen: [222.4-ft]
Fill, 223.4-225.0-ft
Depth to bottom of borehole: [225.0-ft]

Drawing By: RKL/2W23-15.ASB Date: 20Apr93
Reference:

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-15

WELL DESIGNATION	:	299-W23-15
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	SST, S/SX Farm
HANFORD COORDINATES	:	N 34,993.1 W 75,803.1 [200W-13Dec91]
LAMBERT COORDINATES	:	N 440,100 E 2,219,432 [HANCONV]
		N 134,127.23m E 566,794.00m [NAD83-13Dec91]
DATE DRILLED	:	Dec91
DEPTH DRILLED (GS)	:	225.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	189.8-ft, Nov91;
		192.2-ft, 20Apr93
CASING DIAMETER	:	4-in stainless steel, +0.8~185.7-ft;
		6-in stainless steel, +3.43~0.5-ft
ELEV TOP CASING	:	655.44-ft [NGVD'29-13Dec91]
ELEV GROUND SURFACE	:	652.01-ft, Brass cap [NGVD'29-13Dec91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	185.7~222.4-ft, 4-in #20-slot stainless steel;
COMMENTS	:	FIELD INSPECTION,
		OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	SST Monthly water level measurement, 23Jan92~26Mar93;
		Not on water sample schedule
PUMP TYPE	:	Hydrostar, intake at 222.1-ft (TOC)
MAINTENANCE	:	

APPENDIX E

COMPARISON OF EXPECTED AND OBSERVED MOBILE TANK WASTE CONSTITUENT CONCENTRATIONS IN GROUNDWATER

CONTENTS

TABLE

APPENDIX E

COMPARISON OF EXPECTED AND OBSERVED MOBILE TANK WASTE CONSTITUENT CONCENTRATIONS IN GROUNDWATER

1.0 INTRODUCTION

Analytical results for sludge samples retrieved from the S-104 tank in the S Tank Farm may allow development of a profile of co-contaminants and expected concentrations that can be compared to observed concentrations in groundwater. Such data may in turn be useful for determining if SSTs and/or associated disposal structures are the source of observed technetium-99 and other co-contaminants in groundwater downgradient from the S-SX Tank Farm.

2.0 TANK WASTE SAMPLE HANDLING AND ANALYSIS

The analytical results summarized for the S-104 tank (attached summary sheets) are for pretreatment regimes designed to assess the likely composition of waste streams from sluicing and various other steps in the planned processing train that ends with glassification. For purposes of relating possible tank leakage to the occurrence of certain constituents in groundwater, the water extraction treatment referred to in the draft report (TWRSPP-95-021) as "retrieval solution" is the most representative fraction. This treatment step involved mixing water and sludge and analyzing the supernate. Thus, the most soluble constituents would occur in the resulting liquid. Subsequent leaching of solids or residue with caustic solutions (e.g., 10 N sodium hydroxide) are not considered relevant treatments for purposes of estimating mobility potential of tank contents in the vadose zone.

The apparent discrepancy between the technetium to uranium ratio (fact sheet), based on the total tank contents, and the ratio based on retrieval solutions is attributed to the formation of an insoluble uranium phosphate phase in the sludge that does not easily dissolve in water. The potential significance of this observation is that the liquid waste subject to vadose zone transport from the S-104 tank (or other tanks with similar contents) due to a tank leak could have been greatly depleted in uranium relative to technetium-99. Thus high Tc/U ratios would be indicative of a tank waste or related source as compared to a crib source consisting of waste or process streams in which fractionation (precipitation) of the uranium from the technetium did not occur. For example, based on total inventory estimates, the bulk technetium to uranium ratio is about 0.2 as compared to a ratio of 300 to 59,000 in various wash/treatment fractions.

Formation of hydroxy uranyl solid phases because of the elevated pH of the first cycle waste also could result in fractionation or separation of uranium from solution. Because the first cycle waste stream was pH adjusted (up to as high as a pH of 14) before being transferred to the tank farms, hydroxide precipitate or solid phases of uranium also could have been present

in hypothetical leakage from junction or distribution boxes, lines, or tank connection fittings.

Both chemical processes noted previously would result in high Tc/U ratios, thus distinguishing between an actual tank source and a transfer/distribution system source is probably not possible. However, a leak originating in either a tank or the distribution system would yield a Tc/U ratio that is much higher than would occur in any waste or process related discharges to adjacent cribs.

3.0 EXPECTED CONTAMINANT CONCENTRATIONS

The distribution pattern for the occurrence of technetium-99 at the SX Tank Farm suggests an origin from either a SST or from associated disposal structures within or adjacent to the SX WMA. The highest reported technetium-99 concentration occurred in well 2-W23-1 in June 1986. The subject well is located immediately downgradient from the S-104 tank, an "assumed leaker". Thus the (tank) core sample analytical results for the S-104 tank (attachment) are directly relevant to evaluation of technetium-99 in well 2-W23-1. The occurrence of technetium-99 in wells to the south of SX Tank Farm may be due to a combination of S and SX sources. The following analysis is based on the assumption that the S-104 tank is representative of the type of waste discharged or leaked to the soil in the S-SX WMA.

4.0 RATIO ANALYSIS

Based on the analytical results for the water wash fraction of the S-104 tank (attached) sludge or core samples, and the ratios of the mobile constituents of interest, expected concentrations of co-contaminants that should occur along with technetium-99 in groundwater can be estimated. Table E-1 lists the observed and predicted concentrations of key mobile constituents for the RCRA well with the highest recent technetium-99 concentration. This well was chosen for the ratio evaluation because a wide range of analyte data was available as a result of the RCRA groundwater monitoring program. Only uranium, gross beta, nitrate, and technetium-99 data were available for well 2-W23-1.

Table E-1. Expected Concentrations in Groundwater Assuming S-104 is Representative of S-SX WMA Sources.

Constituent (ratio[a])	Observed maximum[b]	Predicted[c]	Natural background	Predicted + natural background
Technetium-99, pCi/L (N/A)	7,800	N/A	N/A	N/A
Sodium, μg/L (5.1)[d]	24,000	39,800	18,100	57,900
Chromium, μg/L (0.12)[d]	47	936	<5	941
Uranium, μg/L (1/59,300)[d]	15	0.13	1.7	1.83
Nitrate, μg/L (7.9)	76,000	61,600	N/A	61,600[e]

[a]Constituent-to-technetium ratios are obtained from SST waste composition fact sheet (see Attachment).
[b]Maximum observed concentrations are from RCRA well 299-W23-15.
[c]Obtained by multiplying the constituent-to-technetium ratio in tank waste by technetium concentration observed in groundwater.
[d]Based on retrieval solution.
[e]The corresponding observed maximum nitrate concentration for well 299-W23-1 was 76,600 μg/L.

5.0 CONCLUSION

The expected mobile co-contaminants associated with technetium-99 in SST S-104 were present in groundwater at well 2-W23-15. However, except for nitrate, comparison of observed and predicted concentrations suggests higher levels of chromium and sodium should have been present in groundwater than were observed. Nevertheless, a small chromium plume does appear to originate in the vicinity of the S-SX Tank Farms, but at lower concentrations than suggested by Table E-1. Allowing for natural sodium levels in ambient groundwater, the net increase in observed sodium was only about 6 ppm as compared to an expected (net) concentration increase of about 40 ppm. Nitrate on the other hand, a major expected co-contaminant, was close to the predicted concentration. It should be emphasized that Table E-1 estimates are based on the assumption that analytical results and test methods for the S-104 tank core samples yield representative mobile constituent concentrations and ratios. There could be considerable variability in tank waste composition from one tank to another within the same tank farm. Also, the water extraction process used on the S-104 tank sludge/core samples may not yield the same co-contaminant concentration ratios as the original fluid that hypothetically leaked from the tank to the soil column. Additionally, some chemical fraction may occur in the soil column that could shift the ratios

from what was expected immediately below the leak source. More tank waste analytical results for the S, SX tanks are needed to evaluate the variability in source term ratios, and sensitivity analysis of constituent transport through the vadose zone is needed to fully evaluate the expected constituent ratios that should be present in groundwater. Also, soil samples from archived cores in the tank farm could be helpful in resolving expected and observed ratio discrepancies. The source term constituent ratio approach, however, does appear to have merit provided the variability question can be resolved.

ATTACHMENT

SST WASTE COMPOSITION FACT SHEET: Summary of S-104 Tank Core/Sludge Sample Analytical Results (TWRSPP-95-021, Draft)

Tank:	S-104, located in northeast corner of S Tank Farm
Status:	An assumed leaker
Sample pretreatment:	Sludge leached with distilled water and caustic solutions
Estimated total U and Tc inventory in tank:	11,000 kg or 7.5 Ci of "total" uranium (U-238, 235,234) 40 Ci of Tc-99
Estimated Tc-99 plume inventory:	0.02 Ci
Ratio of Nitrate to Tc-99	7.9 ± 0.45 μg (NO_3-N)/pCi (mean of all treatments)
Ratio of Tc-99 to U(pCi/μg)	59,300 (Retrieval solution) 935 (First caustic leach) 447 (Second caustic leach) 300 (Wash)
Ratio of sodium to Tc-99(μg/pCi)	5.1 (Retrieval solution)
Ratio of chromium to Tc (μg/pCi)	0.12 (Retrieval solution)

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